FC 1 (2)

NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

A PERFORMANCE MEASUREMENT SYSTEM
FOR THE AIRCRAFT INTERMEDIATE
MAINTENANCE DEPARTMENT OFFICER

by

Irvin Leon Olden

June 1976

Thesis Advisor: C. P. Gibfried

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER

2. GOVT ACCESSION NO.

3. RECIPIENT'S CATALOG NUMBER

4. TITLE (and Subtitle)

A Performance Measurement System for the Aircraft Intermediate Maintenance Department Officer

5. TYPE OF REPORT & PERIOD COVERED

Master's Thesis; June 1976

6. PERFORMING ORG. REPORT NUMBER

7. AUTHOR(s)

Irvin Leon Olden

8. CONTRACT OR GRANT NUMBER(s)

9. PERFORMING ORGANIZATION NAME AND ADDRESS

Naval Postgraduate School
Monterey, California 93940

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS

11. CONTROLLING OFFICE NAME AND ADDRESS

Naval Postgraduate School
Monterey, California 93940

12. REPORT DATE

June 1976

13. NUMBER OF PAGES

149

14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)

Naval Postgraduate School
Monterey, California 93940

15. SECURITY CLASS. (of this report)

Unclassified

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

12 148 p.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

performance measurement system
AIMD Officer
management control system

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A survey of management control systems presently being employed in the Aircraft Intermediate Maintenance Departments of the U. S. Navy is presented in this thesis and a- new standard performance measurement system is recommended based on an analysis of the existing management control concepts. The recommended standard performance measurement system is developed by first defining key result areas for an Aircraft

DD FORM 1 JAN 73 1473 (Page 1)

EDITION OF 1 NOV 65 IS OBSOLETE
S/N 0102-014-6601

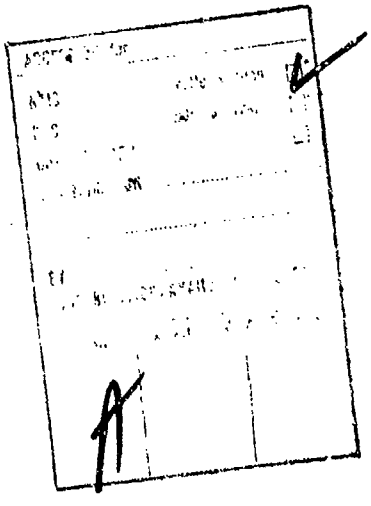
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

1

251450 LB

20. (cont.)

Intermediate Maintenance Department and then constructing measurement indices within each area. This new system incorporates several Navy programs which heretofore have been implemented only on an individual basis.



A Performance Measurement System
for the
Aircraft Intermediate Maintenance Department Officer

by

Irvin Leon Olden
Lieutenant Commander, United States Navy
B.S., University of Missouri, 1965
M.S., University of Missouri, 1966

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN MANAGEMENT

from the

NAVAL POSTGRADUATE SCHOOL
June 1976

Author Irvin L. Olden

Approved by: _____
Thesis Advisor

_____
Second Reader

_____
Chairman, Department of Operations Research
and Administrative Sciences

_____
Academic Dean

ABSTRACT

A survey of management control systems presently being employed in the Aircraft Intermediate Maintenance Departments of the U. S. Navy is presented in this thesis and a new standard performance measurement system is recommended based on an analysis of the existing management control concepts. The recommended standard performance measurement system is developed by first defining key result areas for an Aircraft Intermediate Maintenance Department and then constructing measurement indices within each area. This new system incorporates several Navy programs which heretofore have been implemented only on an individual basis.

TABLE OF CONTENTS

I. BACKGROUND

A. BACKGROUND

This thesis addresses the development of a standardized performance measurement system for use by a shore-based Aircraft Intermediate Maintenance Department (AIMD) Officer. The system that is developed is intended for internal use by the AIMD Officer and his subordinates and is not intended for use by upper-level managers to whom the AIMD Officer reports. The reader is assumed to have a basic knowledge of aviation maintenance concepts.

1. Definition of an AIMD

An AIMD is a department of a Naval Air Station or ship and performs intermediate level maintenance on aircraft removable components such as engines, avionic equipment, ejection seats, etc. In resource management terminology, a shore-based AIMD is a cost center of a Naval Air Station which is designated as a responsibility center [Ref. 1]. The internal organization and functions of an AIMD are prescribed by Ref. 2. An example of a typical AIMD organization is presented in Figure I-1.

2. Definition of a Performance Measurement System

It must be recognized that a performance measurement system emphasizes the comparison of actual results with planned or expected results and is, in reality, just one aspect of a management control system.

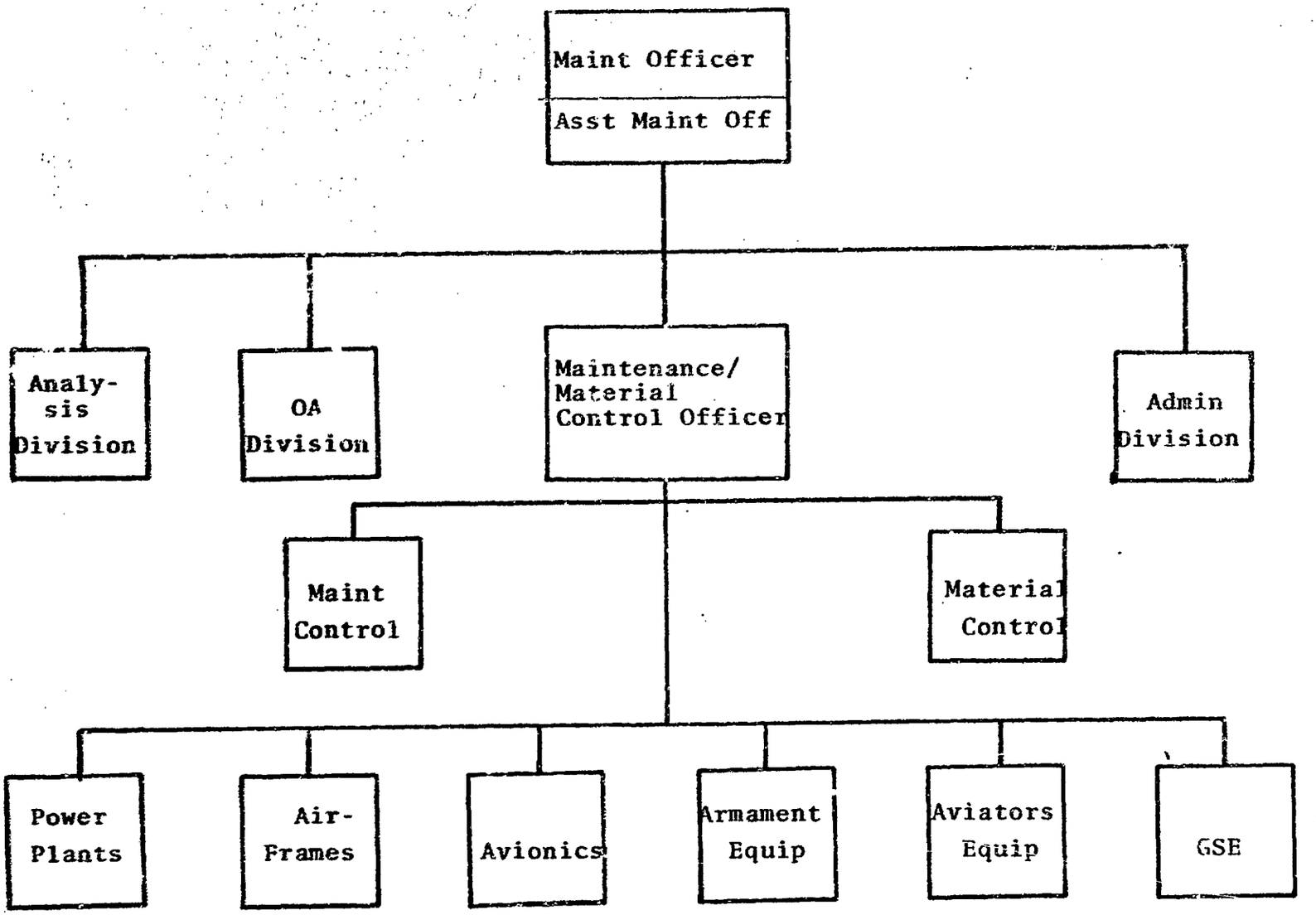

Maint Officer
Asst Maint Off
Analy-
sis
Division
OA
Division
Maintenance/
Material
Control Officer
Admin
Division
Maint
Control
Material
Control
Power
Plants
Air-
Frames
Avionics
Armament
Equip
Aviators
Equip
GSE

Figure I-1

In broad terms, the objectives of a management control system are: to provide a means of communication between the superior and his subordinates, to motivate subordinates through evaluation of actual achievements in light of expected results, and to use recurring reports to appraise the continuing effectiveness of current programs. In other words, a management control system provides a means of communication, performance measurement, and diagnosis. In this thesis, the primary emphasis is placed on the latter two objectives and performance measurement systems will be examined within the context of overall management control systems.

3. Survey of Existing Management Control Systems

This study provides a survey of systems that may be loosely referred to as management control systems which have been imposed on the AIMD's by formal policy (published directives) or which have developed in actual practice. The phrase "loosely referred to" is used because the majority of the systems were not directed towards the establishment of a management control system, per se. They do, however, prescribe: one or another of the objectives of a management control system (i.e., communication, performance measurement, diagnosis), the goals which an organization must pursue, or the structure in which it must perform. In this sense, these systems may be viewed as a form of a management control system.

B. THE NAVAL AVIATION MAINTENANCE PROGRAM (NAMP)

The NAMP is a policy guide, formally promulgated as Reference 2, which describes the overall naval aviation maintenance program. It establishes three levels of maintenance: organizational (squadrons), intermediate (AIMD's), and depot (Naval Air Rework Facilities), and prescribes the functions of each level and their interrelationships.

1. Objectives of NAMP

To the extent that NAMP prescribes the desired objectives of the maintenance program, the structure of the organization, the responsibilities of each key position within the organization, and the relationships among the various levels of maintenance, the NAMP imposes a form of management control. Whatever performance measurement indices are derived, they must relate to the following objectives as set forth in Ref. 2:

a. Improved Performance and Training of Maintenance Personnel

b. Improved Aircraft Availability

c. Improved Maintenance Integrity and Effectiveness

d. Improved Safety

e. Improved Utilization of Maintenance Manpower and Materials

f. Improved Planning and Scheduling of Maintenance Work

g. Improved Quality of End Product

h. Improved Attainment and Retention of Combat Readiness

i. Continuity when Aircraft and/or Personnel are Transferred Between Commands.

It should be noted that these objectives are not mutually exclusive and, in fact, conflict in areas such as improved aircraft availability versus improved planning and scheduling of maintenance work.

C. NATURE OF THE PROBLEM

The AIMD Offficer is faced with a bewildering array of policy instructions issued by the Secretary of the Navy, the Chief of Naval Operations, Commander Naval Air Systems Command, Commander Naval Supply Systems Command, Command Naval Air Force Pacific, etc., which are each intended to provide guidance as to what his goals should be, what functions he should perform, and how he should measure the performance of his organization.

1. The Dilemma of the AIMD Officer

It is currently the problem of the AIMD Officer to integrate the various policy directives, add his own management expertise, and develop a system which will enable him to effectively manage his organization. Since this problem does devolve to each AIMD Officer and he is forced to develop his own system, the result has been that there are now as many different systems as there are AIMD Officers. This approach, however, has the advantage of forcing the AIMD Officer to analyze his particular organization, to seek out the problem areas, and to develop a control system to monitor these problem areas. The disadvantages of this approach are two-fold. First, not all AIMD Officers are equally educated and experienced in developing and applying management control techniques. Hence,

the development of a standardized system could provide a transfer of knowledge from the more experienced officers to those with lesser experience. Secondly, from a higher level management standpoint, it is difficult to compare the performance of one AIMD with another because of the difference in management systems employed. Thus, if a standardized system were to be employed, higher level management could have a common basis on which to compare the performance of different AIMD's.

2. Significance of the Problems

The AIMD-level of maintenance constitutes a major portion of the overall NAMP. Consequently, there must be a continuing emphasis on obtaining maximum effectiveness in utilization of resources. The most current techniques and innovations in the field of management must be brought to bear on this area whenever it appears that they could improve the effectiveness or efficiency of operations.

D. THESIS APPROACH TO THE PROBLEM

1. Relationship of Thesis to Airtask

This thesis was developed within the context of an Airtask assigned to the Naval Aviation Integrated Logistics Support Center (NAILSC) by the Naval Air System Command. The overall purpose of this NAILSC Airtask is to provide a program to assist the Aircraft Controlling Custodian (ACC) in the technical and management operations of the AIMD. The ACC is an upper-echelon organization such as Commander, Naval Air Force Pacific or Commander, Naval Air Force Atlantic which bears the

responsibility for the proper operation and maintenance of assigned aircraft. Figure I-2 depicts the typical organizational relationships between the ACC's and subordinate units.

2. NAILSC Airtask Requirements

A basic requirement of this Airtask is the development of reports which will reflect the performance of individual AIMD's. One element of the proposed technical approach by NAILSC is the design of a performance measurement system for use by the individual AIMD's which will utilize currently available data sources and which will also allow the AIMD Officer to effectively manage his organization. Other purposes of the proposed technical approach are to define additional management indices required, but not currently available, from existing data sources and to ultimately design a performance measurement system incorporating all required management indices.

3. Thesis Approach to Airtask Requirements

This thesis first examines the overall subject of management control systems from both a theoretical and a real-life standpoint. It then progresses to examination of specific management indices for applicability to the NAMP goals. A survey of existing management control systems is also accomplished and, based on the results of this survey, an attempt is made to select those features of existing systems which appear to provide the information required by the AIMD Officer to most effectively administer his organization. That is, those features which will best facilitate his communication with subordinates, motivation

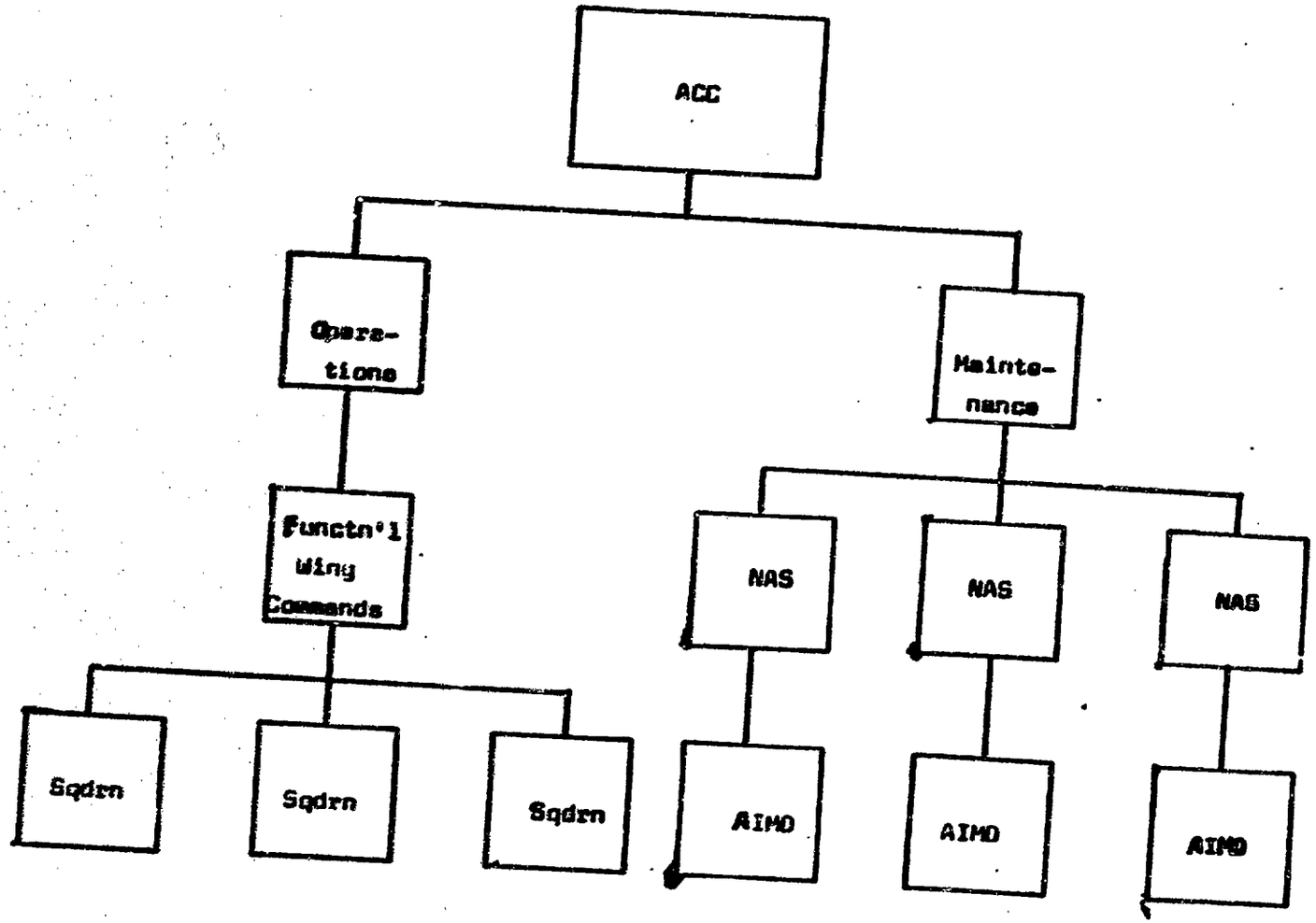

ACC
Opera-
tions
Mainte-
nance
Functn'l
Wing
Commands
NAS
NAS
NAS
Sqdrn
Sqdrn
Sqdrn
AIMD
AIMD
AIMD

Fig I-2

of subordinates through evaluation, and diagnosis of effectiveness of current programs are selected. The many aspects of the problem of management control, as expressed in current theory, are also reviewed and analyzed using the deductive method. With the deductive method, the general, theoretical aspects are reviewed and analyzed first and then the results of this analysis will be applied specifically to the AIMD organizational environment. After this has been accomplished, the promising aspects of each theoretical and actual system will be integrated into an optimum system. Alternative management control systems will also be proposed. Finally, recommendations are made as to the system which should be implemented as the standard management control system, or, more specifically, the standard performance measurement system.

II. THEORETICAL ASPECTS OF THE PROBLEM

A. PLANNING AND CONTROL SYSTEMS

The first thing that must be recognized in discussing management control systems is that there tends to be a distorting generalization in the concept of what a management control process is. If one is unaware of the different types of planning and control processes, then serious mistakes can be made in determining what kinds of data are required as inputs to the information system. There are three basic types of planning and control processes [Reference 3] each of which will be described in turn.

1. Strategic Planning

Strategic planning is the process of determining the objectives of the overall organization (the U. S. Navy), the resources to be used in accomplishing these objectives, and the policies to govern the acquisition, use, and disposition of these resources. For this thesis, the NAMP may be construed to be the result of the latest iteration of the strategic planning process. Revisions of NAMP reflect the continuing changes in maintenance philosophy (such as the phase maintenance concept) and the realities of budget constraints (shifting of functions from depot to AIMD levels). The significance of the strategic planning process and the reason it is germane

to this thesis is: strategic planning sets the guidelines for the management control process. This is what determines the context in which the management control process must occur.

2. Management Control

Management control is the process by which managers insure that resources are obtained, used, and disposed of, effectively and efficiently, to accomplish the objectives of the organization. The process of management control and the system by which it is carried out in the AIMD organization is the topic of this thesis and it should be noted that many constraints, within which the management control system must operate, are imposed by higher-level management. For example, objectives and organizational structure are prescribed by the NAMP: manning levels and budget constraints are imposed by the Type Commander (e.g., Commander, Naval Air Force Pacific) through the parent Naval Air Station. Thus, the purpose of the management control process is to accomplish the stated organizational objectives, effectively and efficiently, within the imposed constraints. A description of this process, in greater detail, follows.

3. Operational Control

Operational control is the process by which managers insure that individual tasks are accomplished effectively and efficiently. Here the emphasis is on individual tasks within a shop or work center and not on the overall performance of the shop or work center. In the AIMD environment, this process is typified by the production control function which schedules

and monitors the progress of individual components undergoing maintenance.

4. Information Systems

One feature that all three of the above planning and control processes have in common is that they are generally categorized as information systems. The placement of all three processes in the same category may explain the widespread misconception as to what the management control process is since it tends to blur the distinctions between the different processes. To make things worse, there are other so-called "information systems" which generate operating information and financial information. Operating information is information which is routinely generated in carrying out daily business. Typical examples of this kind of information (more properly referred to as data) in the AIMD environment are completed Maintenance Action Forms (MAF's), Support Action Forms (SAF's), and standard material requisition forms (DD-1348's). Perhaps the best way to distinguish between these various "information systems" is to avoid the use of the term. Instead, one should think of the latter two systems (financial and operating) as data base systems and the planning and control systems as exactly that . . . planning and control systems. The information contained in the data-base system is then the source of inputs to the planning and control systems. Since the focus of each of the planning and control systems (i.e., strategic planning, management control, operational control) is different, then it should be expected that the type of data input required

for each might also be different. This is at the heart of the problem of designing a planning and control system. What is the desired output and what inputs are required to develop the desired output? Next, attention is turned to specific considerations of developing a management control system.

B. SELECTION OF TYPES OF PERFORMANCE MEASUREMENTS

1. Overall Considerations

As previously mentioned in the discussion of strategic planning, the management control process must occur within certain established constraints. In terms of the AIMD organization, these constraints are objectives, organizational structure, manning levels and budgets. It should be recognized that these constraints directly affect the choice of performance measurements to be applied. Other factors, such as the nature of the business in which the organization is engaged, must also be considered.

a. Organizational Characteristics

The AIMD Officer typically has little or no control over organizational characteristics. He does not select the market he will serve (e.g., the types of aircraft or related components for which he will provide maintenance services). He does not decide on the types or amounts of capital investment he will make in his department (e.g., which types of maintenance equipments in which he will invest). He does not determine the level of personnel resources he will have (neither on a program basis, nor on a current department-wide

basis). He does, however, have an input to budget requests but any short-fall in requested budget funds does not permit a similar decrease in services to be provided. It would, therefore, appear that the AIMD Officer has very little control over the variables which determine what he does and the resources he has available to do it. Remembering that the process and purpose of management control is to accomplish stated organizational objectives, effectively and efficiently, within given constraints (paragraph II, A 2), it is easy to understand how one could fall into the trap of confusing strategic planning with management control and vice verse. The constraints imposed by these characteristics must be considered in the development of performance measurements for use by the AIMD Officer.

b. Overall Strategy

The overall strategy of the U. S. Navy must be considered in developing a management control system for the AIMD Officer. What are the objectives of the U. S. Navy and what is expected of the AIMD Officer? Appendix B of Reference 4 outlines the general strategic principles employed by corporate management and compares and contrasts these principles with the so-called "Principles of War." It is useful to review this interpretation of the Principles of War and determine which of them are reflected in the NAMP. The principle entitled "Objective" states that every military operation must be directed towards a clearly defined, decisive, and attainable objective. This is provided for in the NAMP. (See the list of objectives in paragraph II B 1).

The next two principles, "Mass and Economy" have to do with the proper allocation of resources. The principle of "Mass" indicates that superior combat power must be concentrated at the critical time and place for a decisive purpose. The principle of "Economy" requires that a mission be accomplished with a minimum expenditure of resources. In essence, these two principles are just another way of describing effectiveness and efficiency; which again are two concepts encompassed by the NAMP.

One final principle which seems to be applicable to the NAMP is that of "Maneuver." This principle states that one should always preserve freedom of action and reduce vulnerability. This, in turn, requires flexibility in organization, administrative support, and command and control. Again, this concept is also embodied in the NAMP since it provides the AIMD Officer with the authority to deviate from the prescribed policy if it is required to maintain or improve operational readiness. It would appear that the principles of strategy employed by corporate-level management in the business world are similarly employed by "corporate-level management" in the U. S. Navy and reflected in NAMP.

2. Development of Performance Measurements

a. Principles Involved

Once the constraints imposed by strategic planning have been considered, the next question that arises is, "What principles should be applied in developing the performance measurements?" A research team working for the General Electric Company has developed several such principles [Reference 3].

First, measurements should be designed to assess the performance of organizational components rather than that of the managers of the components. In the AIMD environment, this would equate to measuring the performance of the various divisions and work centers rather than the respective Division Officers and Work Center Supervisors. Second, the measurement indices, but not the standards of performance, should be common between departments, divisions, or work centers. In other words, standards of performance established for one work center (x number of labor hours/unit of output, etc.,) should not be applied to all other work centers; but the same measurements indices (labor hours/unit of output, etc.,) should be utilized.

Third, measurements should be designed as an aid to judgement and not as a substitute for it. The most obvious example of the application of this principle would be the situation where a work center which had been performing at a level of 40 labor hours/unit of output should suddenly rise to 80 labor hours/unit of output. The dramatic increase in the index would not automatically tell the manager that he should put on a second shift, buy more equipment, etc., but rather it would indicate to him that something has changed and he should investigate. Fourth, measurements should somehow provide proper weight to future performance as well as current performance. A typical example might be the situation wherein a work center supervisor or division officer decides to put his work center on a double-shift basis in order to work off

a backlog, compensate for reduced capability of maintenance equipment, etc.. The performance measurement should reflect that this situation cannot be sustained indefinitely and that future performance may be adversely affected.

Finally, the measurements should be designed so as to facilitate constructive, not restrictive action. An example of this principle is a measurement which would favorably reflect the implementation of time-saving procedures such as more efficient maintenance procedures or maintenance scheduling.

b. Key Result Areas

The first step in developing the performance measurements is to determine the specific areas for which measurements should be designed to provide a picture of the overall performance of the department. These measurements should also facilitate the performance of the various aspects of management such as planning, organizing, and staffing. These areas may be determined by a careful analysis of the nature and type of work performed by each sub-unit (work center) in order to determine which factors seem crucial to the accomplishment of defined objectives. Eight key result areas were established for the General Electric Company [Reference 3]. A listing of each of these areas and a description of appropriate indices, are presented in Table II-1.

C. PROFIT VS. NON PROFIT ORGANIZATIONS

The question naturally arises as to whether any of the key result areas developed by the General Electric Company might

Table II-1

GENERAL ELECTRIC KEY AREAS

General Electric Key Area	Purpose of Index
Profitability	°Recognize contribution of capital investment and profits. °Recognize contribution of manpower and profit. °Recognize "organizational facts of life." °Serve to make operating decisions in best interest of overall company.
Market Position	°Recognize share of the market obtained during the period.
Productivity	°Measure relationship of output of goods and services in relation to resources consumed. °Recognize capital and labor input. °Eliminate improvements/degradations contributed by outside sources.
Product Leadership	°Appraise ability of business to lead its industry in applying most advanced knowledge in development of new products/improvements in quality or value of services.
Personnel Development	°Measure the degree and effectiveness of systematic training of managers and specialists.
Employee Attitudes	°Determine the degree of job satisfaction, dissatisfaction.
Public Responsibility	°Determine the degree of responsiveness to certain special publics who have a stake in their venture.
Balance Between Short-Range and Long-Range Goals	°Emphasize the importance of long-term survival and growth.

also apply in the AIMD environment. In order to answer this question, the difference and similarities of profit and non-profit organizations must first be understood.

1. Classification

As pointed out in Reference 3, almost all organizations can be classified into one of two categories: those that exist to earn a profit and those that exist to provide a service. In the first case, the measure of success is primarily determined by how much profit is earned, and in the second case, by how much profit is provided. An AIMD clearly falls into the latter category.

2. Similarities

There are several similarities between the two types of organizations. Both types use inputs to produce outputs; both have management control systems, formalized or not; and both must accomplish the task of programming, budgeting, performance analysis and reporting.

3. Principal Difference

The principal difference in the two types of organization is the lack of a profit measurement for the non-profit organization. The effectiveness of an organization is measured by how well outputs accomplish organizational goals. The efficiency of an organization is measured by the relationship between inputs and outputs. The profit-type organization is able to use the amount of profit as an overall measure of both effectiveness and efficiency, whereas the typical output of a non-profit organization is not measured in these terms and in most

cases cannot be. Thus, the most difficult problem in developing a management control system for a non-profit organization lies in the identification of adequate output measures.

4. Other Differences

In the case of profit organizations, an increased demand for services is associated with attendant additional income which provides the funding for these increased services. This relationship does not hold for non-profit organizations. Consequently, in profit-type organizations additional customers are viewed as oppportunities, whereas in the non-profit type of organization, they are more likely to be viewed as problems due to fixed budget constraints [Reference 3]. Another difference lies in the exposure to external pressures. The managers in non-profit types of organizations are often subject to strong external pressures to take actions that are not consistent with the optimum use of resources [Ref.3].

D. KEY RESULT AREAS FOR AIMD ORGANIZATIONS

1. Non-Profit Organization Analogs

Returning to the question of whether or not the key result areas developed for the General Electric Company might apply to the AIMD organization, it is clear that those areas which reflect a success criterion of profit do not apply. However, if the word "service" is substituted for the word "profit" in the listings of purposes of indices which appear in Table II-1 and other words or phrases more appropriate to the AIMD environment are also substituted, then the analogs as presented in Table II-2 appear.

Table II-2

AIMD KEY AREAS

Key Result Area	Purpose of Index
Service	°Recognize contribution of capital investment to service provided. °Recognize contribution of manpower to service provided. °Recognize "organizational facts of life." °Influence managers to make operating decisions in best interest of the overall organization (U. S. Navy).
Market Service Position	°Recognize share of market serviced by the AIMD during the period.
Productivity	°Measure the relationship of outputs to resources consumed. °Recognize capital and labor inputs. °Segregate the effects of outside sources from the measurements.
Service/Product	°Appraise the initiative of the AIMD in applying the most advanced knowledge in development of new products/improvements in quality or value of services.
Personnel Development	°Measure the degree and effectiveness of systematic training, both formal and on-the-job, of managers and technicians.
Personnel Attitudes	°Determine the degree of job satisfaction/dissatisfaction.
Inter-Command Responsibility	°Determine the degree of responsiveness to certain specific commands (e.g., Functional Wing Commanders, Squadrons) who have a vested interest in AIMD performance.
Balance Between Short-Range and Long-Range Goals	°Emphasize the importance of long-term visibility in terms of growth in base-loading modification programs, etc..

2. Interpretation of Analogs

What has been done thus far is merely a mechanical transformation. Each of the key result analogs presented in Table II-2 will now be analyzed to determine if it has a realistic interpretation in the AIMD environment. It would seem appropriate at this point to emphasize the critical nature of attempting to translate the key areas developed by the General Electric Company into appropriate key result areas for an AIMD. The key result areas developed by General Electric are the result of in-depth, extended research. In total, they reflect the overall performance of the organization in a general, broad sense. The general applicability of these areas is the very quality which makes it possible to translate them in terms of the AIMD environment. The purpose of this thesis is to develop a performance measurement system for the AIMD Officer and this translation establishes the foundation of this system.

a. Service

As suggested earlier, the measure of success for a non-profit organization such as an AIMD, is how well it provides its assigned service. This is in contrast to the profit organization which uses as its primary measure of success the amount of profit generated. Is this description applicable to the AIMD organization? What does an AIMD do? Basically, it performs assigned maintenance tasks on designated aircraft components and certain ground equipment. It does not produce anything in a manufacturing sense. It does not "own" any of the items undergoing maintenance and it does not sell

any of these items. AIMD merely provides a variety of services. It appear then, that "service" as an analog to "profitability" is a reasonable key result area. Turning to the appropriate measurement index for this area, the question arises as to whether or not the purposes indicated in Table II-2 actually apply. It seems reasonable that the contribution of capital investment (i.e., the various test benches, associated software, etc.) to the service provided should be reflected in whatever indices are developed. It also seems reasonable and appropriate to measure the contribution of manpower to this service.

What about "organizational facts of life?" What are these facts? Basically, they are facts such as a particular test bench or fixture not performing as designed (not due to malfunction, but rather due to over-optimistic specifications or a chronic lack of fully trained personnel due to Navy-wide manpower shortages. These are facts of life that the AIMD Officer cannot control and which vary from one AIMD to another. One last purpose of the indices is that of influencing managers to make operating decisions in the best interest of the overall organization. This is particularly difficult to define in terms of the AIMD organization, but some examples might be, needless BCM actions (return of components awaiting maintenance to depot or contractor repair facilities) merely for the purposes of reducing backlogs or tolerating marginal conditions as long as the work center keeps producing.

b. Market Service Position

In the profit type organization, the market service position is quite important in that it indicates how well the organization is doing in relation to its competitors. If the organization is gaining a larger share of the market, then it is doing well. As indicated previously, this is not the situation with the non-profit type of organization. Rather, as indicated earlier, additional customers (i.e., larger share of the market) are viewed as problems rather than opportunities. Nevertheless, a somewhat comparable situation exists in that the size of the market being served by the AIMD is constantly changing as the squadrons come and go on deployments and as new squadrons are formed and others decommissioned. Such factors should be taken into consideration, both in terms of current workload requirements and long-term forecasting.

c. Productivity

The first purpose of the index to be developed in this area is to measure the relationship between the output of goods and services and the resources consumed. This is another way of saying that the efficiency of the organization should be measured, a well-recognized requirement. The second purpose of an index is to recognize labor and capital inputs. Again, this seems reasonable since an improvement achieved by either factor should be recognized. Finally, the effects of improvements or degradations contributed by outside sources should be segregated and then accounted for separately. These effects are quite common and their total impact may be more severe than

expected. A common example of this effect is the induction and troubleshooting of a component which turns out to have no defect at all. When this occurs, useful manhours are wasted which, of course reduces productivity. Another example is the instance where a component has been inducted, a faulty subcomponent has been isolated, and no available spare part is in stock to replace the faulty component. When this occurs, a certain amount of reassembly and/or packaging must be done before the component can be transferred from the workbench to a storage area to await parts.

A final example is the situation wherein a high priority requirement comes in which requires the immediate induction of a component and consequent reconfiguration of the test bench. In this case, the production line must be shut down, the test bench reconfigured for the priority component, and then repair of the component effected. If a component were actually in process when the high priority requirement came in, and repair could not be easily completed, then manhours would be wasted in partial reassembly and/or packaging. The test bench might also require additional reconfiguration upon completion of repair of the high priority component.

These examples represent degradations of potential productivity by external sources (i.e., faulty troubleshooting of components turned in by squadrons, failure of supply system to stock sufficient spare parts, direction by higher authority to give priority to a certain component, etc.).

d. Service/Product Leadership

Service/product leadership represents the degree of progressive effort occuring within the organization. Are personnel seeking new and better ways of doing things or are they content to perform their work "by the book" in a mechanical, plodding manner? This is certainly a fertile key area in the AIMD environment.

e. Personnel Development

Personnel development is probably the most complicated area in the AIMD environment due to the dual nature of AIMD personnel. Not only does the AIMD have permanently assigned personnel, but also a continuing flow of personnel sent from squadrons on a temporary basis. On the technical side, each of these individuals is expected to have a certain amount of formal training and on-the-job training. On the military side each of these individuals is expected to complete certain required courses and successfully compete for advancement in rating. In addition, each individual has his own personal aspirations for development. The transient nature of much of the work force and the diverse requirements of each individual make this a key result area in the AIMD environment.

f. Personnel Attitudes

As mentioned above, each individual has his own personal aspirations. The degree to which his work environment (in this case, the AIMD) conflicts with or promotes the realization of these aspirations will be reflected in the individual's attitudes towards the organization. Recent research [Ref. 5]

has found that some workers are content to perform their eight hours of work, day after day, and be completely satisfied. Other workers, however, have a very strong need to get ahead or to feel that they are getting ahead and have this expectation of their job and the organization for which they work. This would seem to be especially true for young sailors, many of whom joined the Navy to obtain training, to obtain experience, and to get ahead. This area is extremely important to a high level of morale and performance in the AIMD.

g. Inter-Command Responsibility

The purpose of the index in this area is to determine the degree of responsiveness to certain commands who have a vested interest in the AIMD performance. The AIMD has many commands to which it responds. To name a few: the squadrons it serve, respective Functional Wing Commanders, Type Commanders (such as Commander, Naval Air Force Pacific), and of course the AIMD's parent Naval Air Station. The diverseness of these interested parties indicates both how complicated this area is and how important it is. Again, the area of inter-command responsibility would appear to be a key result area for the AIMD.

h. Balance Between Short-Range and Long-Range Goals

All of the key result areas mentioned have, in fact, both a short-range and a long-range implication [Ref. 3]. This key result area is set forth separately primarily to emphasize the importance of thinking ahead in terms of what the future might bring. For example, in the key result area of service, one of the purposes of the index is to reflect "organizational

facts of life." One of the examples of these facts cited was that of a particular piece of test equipment not performing to specifications. If this specification happens to be the Mean Time to Repair (MTTR) of certain components, then the long-term implication is that perhaps either design changes must be accomplished to bring the equipment up to specifications or additional personnel must be programmed to accommodate the increased MTTR actually realized. The short-term implication perhaps is that personnel must be worked overtime to accommodate the higher MTTR. Another key result area is that of market service position. If long-range planning calls for the introduction of several new types of aircraft aboard the parent Naval Air Station, what are the implications for the AIMD? Will additional personnel and maintenance equipment be required? Have these factors been taken into account by the appropriate project office at the Naval Air Systems Command level? If a type of aircraft presently being serviced by an AIMD is becoming obsolete and will be taken out of service, what plans are being made for removal of applicable equipment or reduction of personnel. Are some of the personnel performing maintenance services for the type of aircraft to be deleted also cross-trained and performing maintenance on other types of aircraft? What will be the impact if the billets (positions) to which these personnel are assigned are deleted? In view of the frequent occurrence of the situation wherein managers spend so much time concentrating on solving the problems being encountered on a daily basis that they lose sight of the long-range goals and problems, this area if of keen importance to the AIMD Officer.

i. Other Key Result Areas

It would seem that all of the areas discussed above could be interpreted as key result areas. But recall that all of these areas have been obtained by interpreting analogous areas developed by the General Electric Company. Since General Electric is a profit-type organization and the AIMD is a non-profit organization and there are obviously differences in the nature of their operations, a legitimate question to ask is whether there are other areas which should be considered as key result areas for the AIMD. Before answering the question, it would be appropriate to review the difference between the two types of organizations. As discussed previously in paragraph II A 3 c, the basic difference between these two types of organizations is that the measure of success of the profit organization is the amount of profit generated whereas the measure of success for the non-profit organization is how well its intended service is performed. This basic difference has been resolved in general by substituting the concept of service for that of profit The remaining differences, indicated in the same paragraph, serve to complicate the task of the manager of the non-profit organization in comparison to the task of the manager of the profit-type organization, but do not reflect any real differences in the nature of the two organizations. The point is that there does not appear to be a significant functional difference in the two types of organizations once the profit motive has been taken into account. Hence, it would seem that although there may be other key result areas applicable

to the AIMD environment, the key result areas discussed above will provide adequate measures of the overall performance of the AIMD.

E. MANAGEMENT CONTROL PROCESS

The objective of this section thus far has been to distinguish management control from strategic planning and operational control, to define key result areas for an AIMD, and to describe the purposes of performance measurement indices within each area. The end result of these efforts will be the establishment of an explicit frame of reference (in terms of performance measurement indices) to serve as a vehicle for communication, motivation through evaluation, and diagnosis of the continuing effectiveness of current programs. The accomplishment of the first two objectives, communication and motivation, is in itself insufficient. Communication may be excellent, work centers may be performing at or above planning levels,, but the AIMD Officer cannot be content with this knowledge. He must be able to look beyond the current situation and evaluate the future impact of today's events on tomorrow's requirements. He must ask himself if the current nature and magnitude of operations will be appropriate to the future environment he will face. In order to answer these questions, the AIMD Officer must carry out the various steps of the management control process.

1. AIMD Management Control Process

The management control process is described in Reference 3 as consisting of six elements:

a. Environment Scanning and Analysis

b. Business Planning

c. Programming

d. Budgeting

e. Reporting Operating Results

f. Analysis of Performance

In decentralized organizations, such as the Navy, the first two elements are accomplished at the headquarters level. In general, these two elements involve staying attuned to what is happening in the real world and how to react to these world developments. The management control process as it would occur in the AIMD environment consists of the remaining four elements. Each will be discussed below.

2. Programming

This elements consists of the development of a time-phased plan of action that is intended to execute the overall goals of the organization. This element is sometimes referred to as long-range planning, and may be formulated in terms of markets or customers (i.e., aircraft types) and cut across several responsibility or cost centers.

3. Budgeting

This element consists of an operating plan for the coming year. It is expressed in terms of funds and manpower and is formulated in terms of responsibility or cost centers. The budget should be a one-year slice of the programs developed during the programming step, recast as necessary in terms of responsibility center resources.

4. Reporting (Internal)

Actual results must be summarized and reported against the appropriate responsibility centers. If these results are collected against the same set of responsibility centers, then the development of reports required for performance evaluation should require little extra effort.

5. Analysis of Performance

The management control system, among other things, should provide a means of comparing actual results with goals previously established and for analyzing any resulting variances. It should be noted that these goals are not in terms of specific work centers, but in terms of plans and programs. If the results are not meeting expectations, then management is alerted to the fact that corrective action is required to either improve performance or revise budgets to a more realistic level.

III. EMPIRICAL ASPECTS OF THE PROBLEM

A. ELEMENTS TO BE MANAGED

As discussed in paragraph II, A 2, the purpose of a management control system is to insure that resources are obtained, used, and disposed of, effectively and efficiently, to accomplish the organization's objectives. In terms of the AIMD environment, what are these resources? Reference 6 lists several elements which must be effectively managed in order to obtain an acceptable level of support. Some of these elements can be viewed as resources to be utilized while others appear as contraints to be observed in order to accomplish the overall mission.

1. Maintenance Concept

Each type of aircraft being supported by an AIMD should have associated with it a definite maintenance concept developed by the prime contract in conjunction with the NAVAIR program office during the design phase. Each concept embodies a philosophy of how that particular type of aircraft and its associated systems will be maintained. Specifically, what maintenance functions (i.e., checkout, servicing, fault isolation, replacement, etc.) will be performed at what level (squadron, AIMD, or depot)? Under a particular philosophy, the emphasis on squadron-level maintenance may be for extensive use of automated troubleshooting procedures through built-in test equipment or, instead, the emphasis may be on the use of highly trained squadron technicians with basic items

of test equipment to troubleshoot the aircraft and associated systems. The definition of the maintenance concept for a given system, though far removed from the realm of the AIMD Officer, nonetheless imposed some very real constraints which the AIMD Officer must operate under.

As an example, one result of this definition process is the classification of a component as "repairable" or "throwaway." A Level of Repair (LOR) analysis, essentially an economic screening technique, is conducted to place a component in either a repair or discard category. The discard category is self-explanatory and simply means that the component will be thrown away instead of being repaired. The repair category may be dividied into two sub-categories: repair locally (at AIMD) or repair at depot level. The technique is explained and presented in Reference 7. Individual cost elements are expressed in terms of f_m (the mean number of removals pers maintenance cycle) and C (unit cost). The costs for various ranges of f_m values are computed for each of the three disposition categories (i.e., discard, repair-local, repair-depot). Particular values of C and f_m are then determined at which there is no difference from an economic standpoint between throwing away and repairing. After these values are obtained for a range of f_m values, then an economic screening curve such as that depicted in Figure III-1 may be obtained by plotting these values.

The AIMD Officer can do little to control the maintenance concept of an aircraft being supported. Rather, he

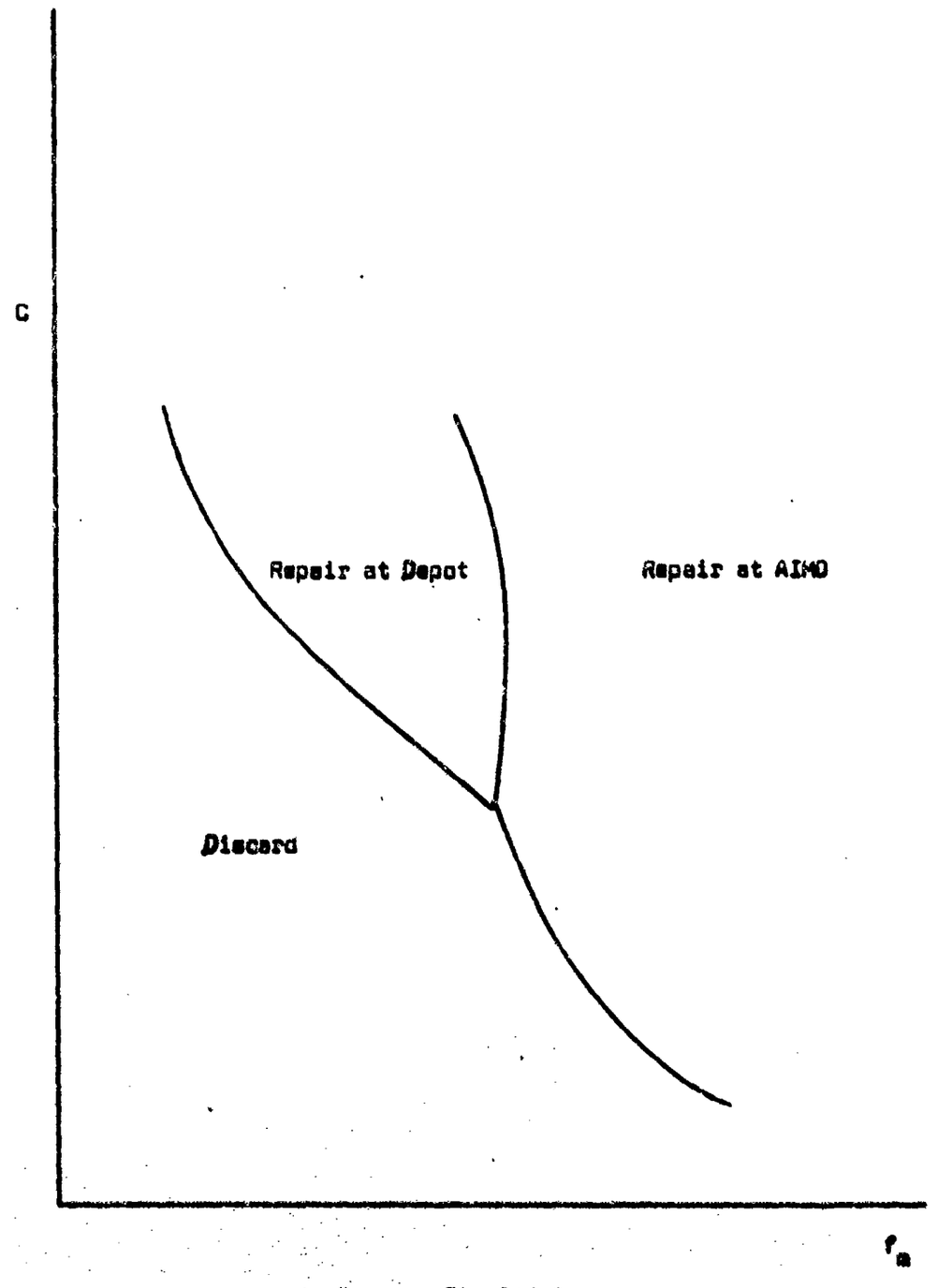


Fig III-1

must live with the constraints imposed by this concept. He must be aware of how the aircraft system was designed to be maintained and what is currently being realized in actual practice. If the design approach was for built-in-test equipment (BITE), does actual experience indicate that the BITE is not performing satisfactorily either through excessive "no defect" removals (over-sensitive BITE) or higher MTBF's than expected (under-sensitive BITE)? In other words, the design philosophy embodied in the maintenance concept is not so much a resource that can be controlled, as it is a constraint that sets the stage on which the AIMD Officer must perform.

The AIMD Officer is also charged with the responsibility of general and special purpose ground support equipment such as the test benches and the various rolling stock referred to as "yellow gear." These equipments will also have a maintenance concept associated with them. Again, the AIMD Officer must be aware of what these maintenance concepts are and what constraints they impose on his operation.

2. Support and Test Equipment

As discussed above, the maintenance concept will specify certain maintenance functions to be accomplished at the AIMD level. The accomplishment of these functions will require the use of certain items of common (or standard) support and test equipment such as voltmeters, oscilloscopes, etc., and certain items of special (or peculiar) support and test equipment which have been designed specifically for

the repair of a particular type of aircraft and associated systems. The AIMD Officer must be able to monitor the status of the various equipments under his control, be aware of Navy-wide program plans for retrofit programs or removal from service, and compare actual performance against design parameters.

3. Supply Support

This element impacts the AIMD operations in two ways. First, the AIMD responds to the Supply Department by repairing failed components and returning them to a ready-for-issue (RFI) status. In this case, the AIMD functions as a source of supply support. Secondly, as maintenance personnel repair components or test equipment failures, spare parts are often required for replacement of failed units. In this case, the AIMD functions as a customer of supply support.

a. AIMD as a Source of Supply Support

In the former role, the AIMD oftentimes comes under external pressures to increase outputs of certain types of components. This pressure may be somewhat misplaced in that, strictly speaking, the AIMD responds to the Supply Department of the ship or NAS on which the squadrons are located. The Supply Department in turn responds to squadrons for replacement parts. This complaint could perhaps be dismissed as "begging the question" if not for the fact that the Supply System determines the quantities of spare components held in a pool for ready issue. In making this determination, the Supply System must conform with the policies established by higher authorities in the supply echelon.

In the case of establishing quantities of items held in a pool for ready issue, Reference 8 sets forth criteria for making this determination. These criteria involve such factors as turn-around-times (TAT) which is the repair/supply cycle processing times, demand rates, and fill-rate goals, which is the percentage goals of requisitions filled immediately to requisitions received. Reference 9 points out that under these criteria, "Both TAT and demand rates are based on historical data, usually past 90 days . . . Generally, no deviation is authorized in order to select a higher expected fill-rate, regardless of dollar value or military essentiality of the item under review. No provision is made for utilization of predicted future rates, even though present period flight hour/utilization rates are expected to be different than past rates."

Further complicating this problem is the situation where the number of spare components held at a particular support site such as a ship or NAS is determined strictly on the basis of the number of total spares available worldwide. This type of spare component is usually very expensive and spares at each support site are on the order of one to two. The significance is that the number of spares stocked at a given site is based strictly on economics (limited funds determine total number of spares) rather than forecast or experienced failure rates and demand rates. The net impact of this situation on the AIMD is that if the number of spare components held in a RFI status in a pool is insufficient to meet

demand (i.e., low-fill rate) then the AIMD is always under pressure to increase output (i.e., decrease TAT). Although the AIMD Officer may be able to improve the TAT to some extent, he must at some point reach a theoretical maximum of design limitations which still may not be enough to obtain the fill-rate desired.

b. AIMD as a User of Supply Support

While performing maintenance on components inducted for repair, a technician may find a failed part which requires replacement. The technician will then either obtain the needed part from a pre-expended bin (which is located in the vicinity of the maintenance spaces) or through the Supply Department. In either case, the technician can obtain the needed part only if it has been previously stocked by the Supply Department. If the part is not in stock then maintenance ceases and the component under repair is removed to a storage area and classified as "awaiting parts" (AWP) until the needed parts arrive. The number of spare parts to be carried in inventory is determined by a similar process as that described in paragraph III, A 3 d. In either of these cases, the AIMD Officer must contend with situations which are beyond his direct control but which will determine to some extent how his performance will be judged by external commands. Therefore, in both cases, the AIMD Officer has a vested interest in tracking key parameters which will indicate adverse or improving conditions.

4. Transportation and Handling

This element encompasses the functional requirements and actions necessary to ensure a capability to transport, preserve, package, and handle all equipment and support items. The AIMD Officer should be keenly interested in this aspect since it has a potential impact on many facets of his operation. Unless proper packaging and handling procedures are accomplished for failed components being sent from squadrons to the AIMD, additional malfunctions may be induced beyond those found by squadron technicians and documented on the maintenance action forms (MAF's) which accompany the failed units. Similarly, unless proper packaging and handling is accomplished for units which have been repaired by AIMD and returned to the RFI pool or squadrons, then malfunctions may be induced which will make the component appear as if it had not been properly repaired. Another aspect of the transportation and handling element is that of time. Failure to obtain the most expeditious pick up, screening, and induction of components will result in increased TAT's since the figure computed for TAT includes both processing and repair times. Exact procedures, problem areas, and proposed improvements must be worked out in conjunction with the Supply Department, of course, but again the situation exists where the AIMD Officer has a vested interest in obtaining the most efficient operation possible.

5. Technical Data

This element includes drawings, operating and maintenance manuals, parts-breakdown-structure manuals, parts

lists, etc. As before, this area consists of items which were formulated years ago by some party far-removed from the AIMD scene. Yet these are items which have a significant impact on how well the overall AIMD organization performs. If the operating instructions for a piece of test equipment is in error or vague, then it may be worse than no instruction at all. If the maintenance instructions for repairing or aligning a component are in error or vague, then this may result in serious damage to the component, or, if installed, the aircraft system of which it is a part. Not only does the possibility of damage arise, but shortcomings in the manuals, parts lists, etc., have negative spillover effects such as decreased worker morale (one can imagine the frustration of a technician attempting to use erroneous and/or vague procedures), decreased productivity (resulting from excessive amounts of time spent in attempting to interpret or make sense of vague procedures), and negative impact on the Supply Department (resulting from the ordering of wrong parts due to faulty troubleshooting procedures or erroneous parts lists).

6. Facilities

This element is comprised of types of facilities, locations, space requirements and environmental factors (light, power, air-conditioning, etc.). This element is particularly important in the shipboard environment since the increasing technical sophistication of aircraft and associated systems has led to an ever-increasing quantity and diversity of common and peculiar ground support equipment

required to support these systems. Consequently, there has been an ever-increasing demand for additional space to house these equipments and for a diversity of power, water, and air-conditioning services. While this element is of primary interest to the AIMD Officer during introduction of a new support capability, it must be monitored on a continuing basis.

7. Personnel and Training

This element encompasses the establishment of specific manning requirements, pre-requisite training, and on-the-job and formal training programs. There can be little doubt that this element is the heart of the organization. Without people, properly trained and motivated, the organization simply cannot function. Since the organization is primarily technically oriented, it is easy to lose sight of personnel and training requirements in other areas; yet, it is just as important since the key to a successful operation is an organization which is well-balanced from an overall point of view. Yeomen, analysts, and other staff personnel also need training and counseling. Not only do personnel need technical or professional training in their ratings, but also military and leadership training.

8. Support Resource Funds

The elements referred to as Support Resource Funds consist of those activities necessary to determine and compute funding requirements, monitor expenditures, update current requirements, and forecast future requirements. Impact of funding cuts must also be evaluated and adjusting actions taken.

9. Management Information (Internal)

Management information consists of recordable information which is collected and presented as either formal or informal reports. The formal reports are standard maintenance data reports (MDR's) which are a consolidation of data submitted by AIMD to the Data Processing Department and which provide a wealth of historical information. A complete listing of the reports available under the Maintenance Data Collection System (MDCS) is provided in Appendix A. The informal reports are typically individualized documents which have been developed by the incumbent AIMD Officer over his years of experience. These reports are characteristically current (reflect accomplishment of previous working day and backlogs as of current date) and cryptic. This element is also of key interest to the AIMD Officer since it is by means of management information that he stays informed on the operation of his organization.

B. AIMD MANAGEMENT CONTROL STRUCTURE AND PROCESS

Having discussed each of the elements with which the AIMD Officer must come to grips, it is now appropriate to consider the various aspects of the organizational structure within which he must manage.

1. Responsibility Centers

There are several types of responsibility centers (i.e., organizational units). Reference 3 classifies them in a way that highlights the problems of controlling them. The point is made that all responsibility centers produce

outputs (either goods or services) and all have inputs (i.e., they consume resources). The classification of the various types of reponsibility centers in Ref. 3 uses as a criterion the difficulty of measuring outputs, inputs, and the relationship between them. Under this criterion, the following principal types of responsibility centers are identified:

a. Standard Cost Centers

b. Revenue Centers

c. Discretionary Expense Centers

d. Profit Centers

e. Investment Centers

Each type will be briefly described below.

2. Standard Cost Centers

In this type of responsibility center, standard costs are established for each cost center product. Then, a measure of output is determined by multiplying the physical quantity of the output by the unit standard costs for each of the products produced and summing the results. The total actual cost is then compared to the total standard cost of the output and any variance is then analyzed and corrective action taken as required. It should be noted that in this type of responsibility center there are other tasks which cannot be measured by costs alone and it is necessary to control these tasks if the center is to operate effectively. For instance, unless the standards of quality are carefully controlled, a cost center may increase volume of production at the expense of quality.

3. Revenue Centers

This type of responsibility center is not germane to this thesis since it focuses on outputs measured in terms of sales revenue. It is mentioned without elaboration for purposes of completeness.

4. Discretionary Expense Centers

This type of center is unique in that its outputs cannot be measured in terms of costs or revenue. These are typically staff units such as the administrative/personnel sections, the quality assurance division, etc.. In this case, the outputs cannot be defined in such a way that the efficiency or effectiveness of the unit can be quantitatively determined. The only significant measure that can be made is in terms of a comparison of actual inputs to budgeted inputs.

5. Profit and Investment Centers

These two types of responsibility centers are not applicable to the AIMD environment since they contain the element of revenue and profit. Again, they are mentioned solely for purposes of completeness.

6. AIMD as a Discretionary Expense Center

As stated above, two characteristics of a discretionary expense center are: output cannot be measured in terms of costs or revenue; and, the only significant measure is the comparison of actual inputs to budgeted inputs. For this type of responsibility center, it becomes a task of higher authority to determine the magnitude of the job that

is to be done by deciding what tasks should be undertaken and what level of effort is appropriate to each task. This appears to be an accurate description of the AIMD organization when taken as a whole, in view of the following observations. The overall output of an AIMD cannot be measured in terms of costs or revenue. Higher authority decides what tasks will be undertaken (i.e., which aircraft types will be supported, and the various maintenance functions which will be accomplished at the AIMD level). The level of effort is also determined by higher authority by means of budget and manpower allocations. Thus, from an overall, upper-level standpoint, the AIMD may be viewed as a discretionary expense center since the magnitude of its task is determined by higher authority through allocations of funds and manpower. In this case, the only significant measurement is a comparison of the actual inputs to budgeted inputs (in terms of manpower, capital equipment and funds). This is consistent with the discussion of non-profit organizations in paragraphs II A 3 c and II A 3 d in that the output is difficult, if not impossible, to define, and increased demand for services is viewed as a problem since there is not, necessarily, a corresponding increase in budget.

7. AIMD as a Cost Center

As indicated in the previous paragraph, the AIMD when viewed as a whole entity, has the characteristics of a discretionary expense center. When the various individual divisions and work centers within an AIMD are considered,

most appear to have the characteristics of cost centers. Each has a definite, quantifiable output and each consumes a definite, quantifiable amount of resources in terms of manhours and time on test equipment. Of course, there are units within the AIMD such as administration and personnel, quality assurance, etc., which are clearly discretionary expense centers, but the majority of the divisions and work centers within the AIMD appear to be in the category of cost centers.

8. Implications of Existing AIMD Management Control Structure

Based on the interpretations of the two preceding paragraphs, two observations may be made. First, since each AIMD organization, when viewed as an entity, may be considered a discretionary expense center, then the only valid comparison between AIMD's is in terms of how well each adhered to its budget. Secondly, when the AIMD Officer views the various divisions and work centers within his organization, he sees the majority of them in terms of cost centers. In this sense, he may be legitimately expected to develop output measures for the majority of divisions and work centers and judge their performance accordingly.

9. Current AIMD Management Control Process

Turning now to the topic of the management control process, one generalization is made. A survey of existing management control systems indicates that the idealized process as described in paragraph II,E-1-5 (i.e., programming, budgeting, etc.) simply does not exist in most AIMD's.

Certain AIMD's employ fragments of one or more of the elements but, in general, the process actually employed is one which has been developed by the individual AIMD Officer based on his experience, perceptions, and personality. In interviews with various AIMD Officers only one case was found in which data was collected and presented on a program basis. The system of reports received on an internal basis was generally of an overall nature which failed to give detailed insight into performance by division or work center. Of course, the question remains of whether or not the formal process should be utilized by the AIMD Officer. Obviously, the process which has been employed by the many officers who have served as AIMD Officers does work because they have been able to accomplish their jobs very effectively in the vast majority of the cases. However, with the increasing sophistication of aircraft and weapon systems, the task of the AIMD Officer has become increasingly critical and complicated as he is called upon to manage a diverse range of technical skills and test equipments both of which represent a tremendous investment by the U. S. Navy. It appears that the time has arrived when the AIMD Officer needs a more formalized system which will enable him to rise above the press of daily "brush fire" problems and to focus more on the long-range direction of the organization; to stay ahead of the game by acting rather than reacting; and to develop programs and budgets that are accurate, complete, and readily defensible.

C. MAINTENANCE DATA COLLECTION SYSTEM (MDCS)

Recall the discussion in Section II regarding operating information. This is the data that is generated routinely as a matter of conducting daily business. For example, forms such as maintenance action forms (MAF's), the support action forms (SAF's), the requisition forms (DD 1348), etc.. The sum total of this data represents a vast reservoir of potential information, but it must be carefully sifted to obtain the information needed to feed the various planning and control systems, specifically the management control system. Figure III-2 is a graphic representation of MDCS source documents and available reports. The purpose of the overall MDCS and the various subsystems and reports in which the AIMD Officer is primarily interested are briefly reviewed in the following paragraphs.

1. MDCS Requirements

As defined by Reference 10, the MDCS is a management information system designed to provide statistical data for use at all levels of management (i.e., local commands, Type Commanders, headquarter commands, government contractors, etc.) relative to:

a. Utilization of Maintenance Personnel

b. Maintainability and Reliability of Equipment

c. Configuration of Equipment Including Modifications and Technical Directive Compliance Status

d. Readiness and Utilization of Equipment

e. Usage of Maintenance Material

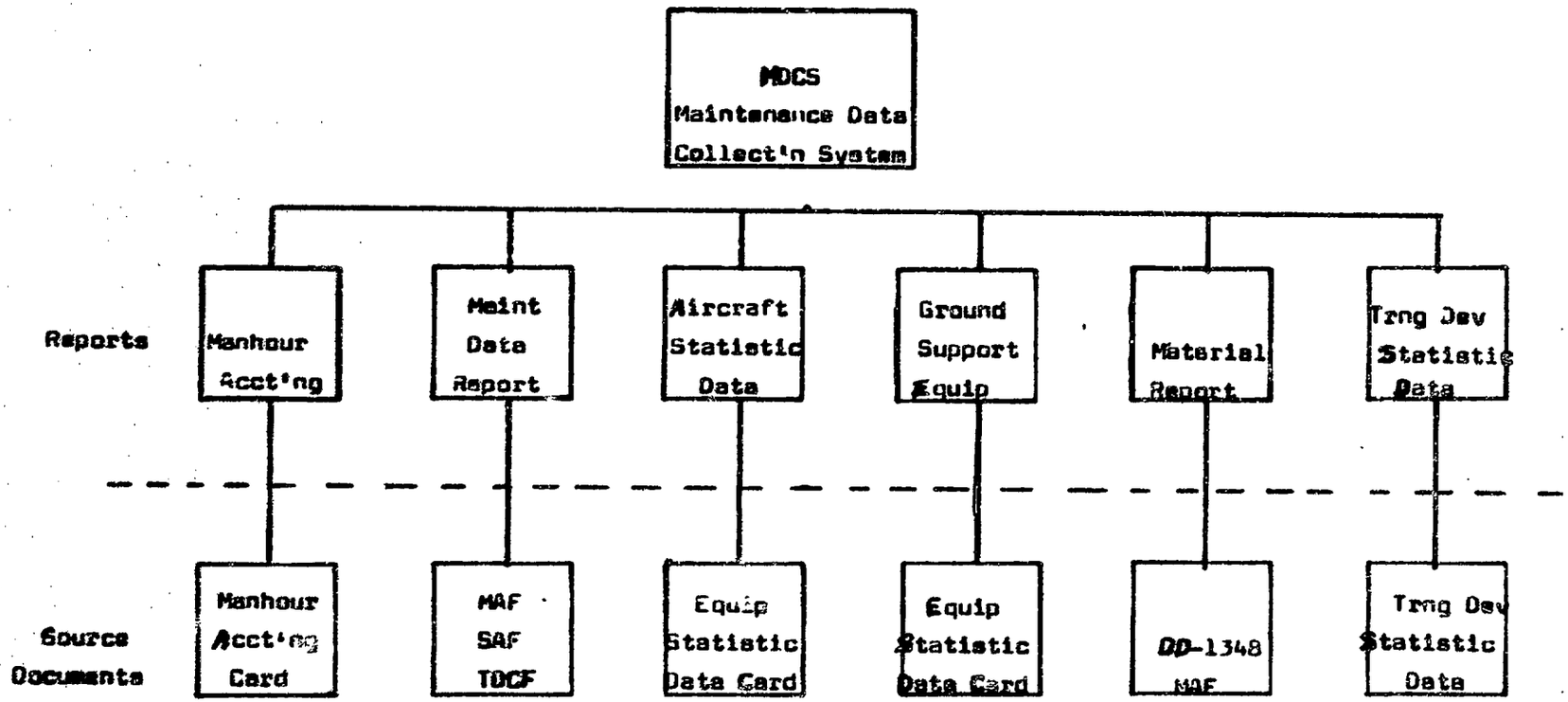

MDCS
Maintenance Data
Collect'n System
Reports
Manhour
Acct'ng
Maint
Data
Report
Aircraft
Statistic
Data
Ground
Support
Equip
Material
Report
Trng Dev
Statistic
Data
Source
Documents
Manhour
Acct'ng
Card
MAF
SAF
TDCF
Equip
Statistic
Data Card
Equip
Statistic
Data Card
DD-1348
MAF
Trng Dev
Statistic
Data

Fig III-2

f. Non-Availability of Material

g. Maintenance and Material Processing Times

h. Costing of Weapon Systems and Maintenance Material Costing

The AIMD Officer is not primarily interested in all of these purposes but should focus on items a, d, and g with secondary interest in items c, e, and f, insofar as they have an impact on his operation.

2. Manhour Accounting (MHA) System

The manhour accounting system is designed to provide all levels of management with manhour utilization data that will promote the effectiveness of personnel distribution, training and assignment. It also provides an accurate measure of manhour employment. Currently, manhour accounting is not mandatory but may be done at the discretion of the Type Commander; however, all activities must maintain a master roster (MHA-00) and submit MHA summary cards. Output reports of the MHA system are listed in Appendix A and briefly described here. The Work Center Daily Labor Report (MHA-1) provides a summary of manhours by individual by work center. The Work Center Monthly Labor Utilization Report (MHA-2) summarizes MHA-1 information on a monthly basis. The labor transactions for the month for each branch or division is provided by the Branch/Division Monthly Labor Utilization Report (MHA-3). The Organizational Monthly Labor Utilization Report (MHA-4) provides a summary of this information on an organizational basis.

3. Maintenance Data Reporting (MDR) System

The MDR system is designed to provide managers with data relating to: direct labor expenditure, reliability and maintainability of parts, components, and equipment, and technical and mission configuration in accomplishing the maintenance mission. This system is designed such that each worker, when performing a task, converts a narrative description of that task into codes and then enters this coded information on standard forms (source documents). These source documents are collected and transmitted to a data service activity where the information is transformed into machine records. These records are then used to produce periodic reports for the use of local managers which lists and summarizes the submitted data as required. The information on the machine records is also forwarded to a central data processing facility where selected data are provided to higher levels of command such as Type Commands and Headquarters Commands.

4. MDR Source Documents

There are four primary input forms or source documents for the MDR system (see Figure III-1). The MAF's (both single and multiple copy versions) describe each significant maintenance action such as troubleshooting, removal and replacement, repair, etc.. The Support Action Form (SAF) is used to identify, report, and monitor the accomplishment of repetitive, time-consuming types of support tasks such as preventative maintenance, corrosion control, etc.. The Technical Directive Compliance Form (TDCF) provides a means

for accounting for maintenance actions taken as a result of technical directives (i.e., modifications) and is a useful planning document for forecasting workloads and material requirements.

5. Maintenance Data Reports

A listing of standard MDR's is provided in Appendix A. Briefly, the Daily and Monthly Production Reports (MDR-1 and MDR-2) summarize, by work center, all maintenance actions reported. The Job Control Consolidation (MDR-3), Technical Directive Compliance (MDR-4-1 and MDR-4-2), and System and Component Maintenance (MDR-5) Reports provide, respectively, a consolidated listing by organization of all maintenance and TDC actions, TDC forms submitted, and MAF/SAF forms submitted. The remaining reports MDR-6 through MDR-11 provide specific information to determine maintenance weaknesses that should be adjusted or corrected. The MDR system may also be utilized to generate special reports which may be of particular interest to certain organizations.

6. Aviation Ground Support Equipment (GSE) Statistical Data System

The purpose of this system is to provide a measure of the readiness and utilization of GSE. There is but one source document, the Aviation Ground Support Equipment Data Card (OPNAV Form 4790/46). There are three primary reports produced from the data on this card. A Monthly GSE Utilization and Master Record Card (GSE-1) which lists all utilization cards submitted on a monthly basis and updates the master roster for the following month. A Daily GSE

Transaction Report (GSE-2) provides a detailed listing of Not-Operationally-Ready (NOR) and inventory change data sumbitted during the monthly reporting period.

D. EXISTING AIMD MANAGEMENT CONTROL SYSTEMS

As discussed previously, the management control systems that are currently being utilized at AIMD's are highly individualized systems that are molded by each AIMD Officer in terms of his experience, his perceptions, and his personality. This is not to say that this approach is wrong or undesirable, but, perhaps, a more formalized approach would result in even better results, particularly if this formalized approach were to be an amalgamation of the best parts of the various existing systems and the systems suggested by modern management theory. Based on several interviews, References 11, 12, 13, and an evaluation report, Reference 14, three "real world" approaches/systems are described below.

1. The Management By Exception Approach (Case I)

Under this approach, the AIMD Officer manages primarily by exception. His primary emphasis is on insuring that he gets "good" people in the key positions (officers, and senior petty officer) that they receive proper training and that these personnel are aware that he is sensitive to their needs and aspirations.

a. Management Approach

This approach to management is, of course, the classical "Theory Y" aproach as described by McGregor [Ref.5]. The assumptions of the "Theory Y" manager are based on the

concept of self-actualization set forth by Maslow. That is, people will work hard and assume responsibility if they are able to satisfy their personal needs while, at the same time, they are achieving the organization's goals. Although most modern theorists seem to be in agreement that this approach can be a very effective style of leadership, it does not lend itself to the application of close management controls.

b. Implications of Approach

The objectives of a management control system, as previously stated, are to communicate, to motivate through evaluation, and to provide a means of diagnosis. With the approach described above, communications is primarily effected by informal means rather than through formal control processes. Further, motivation is obtained from the individual worker by putting him in a situation where he identifies the satisfaction of his needs with accomplishment of organizational goals. This is in contrast to motivating the worker by evaluating his performance against predetermined standards. This means that the primary purpose of a management control system under this management approach is to provide a means for reporting diagnostic information as to the appropriateness or effectiveness of current plans and programs. These reports cannot signal that a change in plans is necessary or what the change should be, but they can alert the manager to the need for investigating whether or not plans should be changed.

c. Observation of Actual System

Diagnosis appeared to be the thrust of the reports received by the AIMD Officer utilizing this approach. The significance of the data contained in the various local reports seems to be in the trends that the data indicated. In general, these data were in terms of number of components restored to RFI condition and those remaining non-RFI (i.e., AWI, WIP, and AWP) for the preceding 24-hour period for each work center. Other reports reflected trend lines for aircraft out of commission for parts (AOCP), those not fully equipped (ANFE), and total number of components in the categories of AWI, WIP, and AWP, all on a daily basis. The determination of overall effectiveness of the AIMD organization was accomplished by comparing a particular AIMD's monthly statistics of the percentages of items processed and made RFI, items processed and declared "beyond the capability of maintenance" (BCM), and those items in storage awaiting parts (AWP) with similar percentages, in composite form, for all AIMD's under the control of a Type Command.

The validity of this comparison seems questionable in view of the fact that each AIMD serves a different type of market. Under this circumstance, a particular AIMD may inherently perform below or above the "fleetwide" average due solely to the nature of the test equipment employed, the maintainability design of the aircraft systems, etc.. In other words, an AIMD may not be performing nearly as effectively as possible, yet still be above the fleet average.

Conversely, an AIMD may be performing extremely well, given its constraints, and still be below the fleet average.

d. Evaluation of Approach

There is little doubt that this type of approach has worked successfully given the appropriate personality of the AIMD Officer. The major disadvantage is that the AIMD Officer develops no explicit measures of progress by which to judge the performance of his organization. His information can indicate unsatisfactory trends, but cannot pinpoint exact problems areas nor suggest courses of corrective action. Instead, the AIMD Officer must rely on the expertise and management ability of his subordinates to analyze problem areas and develop plans for corrective action. In short, he can determine if the performance of his organization is improving but not how much more improvement is necessary or possible; he can determine that the performance of his organization has declined, but not how much further it can decline before serious problems result. The principal advantage of this approach is that the trend information is perceived on a daily basis enabling the AIMD Officer to quickly spot a deteriorating situation and direct investigative action.

2. The Management By Objectives Approach (Case II)

Under this approach, the AIMD Officer allocates explicitly certain objectives to each of the division officers and work center supervisors. These objectives are discussed between the AIMD Officer and his subordinates on a periodic basis and the subordinates are required to defend their accomplishment against those goals. Some goals are short-range

and operationally oriented. Others are long-range and of an innovative nature.

a. Management Approach

The approach outlined above is, of course, a classic example of management by objectives. This concept is outlined in Ref. 5 and is based on the premise that the goals of each manager (i.e., division officers and work center supervisors) and his unit can be tied in to the total objectives and success of the overall organization. That is, management by objectives makes objectives operational by translating them into discrete actions to be accomplished by subordinate managers and their units. It motivates the managers since they are evaluated against specific goals which they understand and have helped establish themselves. This is a typical process in the management by objectives approach. The supervisor (in this case the AIMD Officer) and his subordinate managers jointly define, through dialogue, the subordinates' goals which will contribute to the accomplishment of the overall organization's goals. They jointly define the subordinates' major responsibility areas in terms of what results are expected of him.

b. Implications of Approach

In terms of the now familiar objectives of a management control system (i.e., communication, motivation, and diagnosis), this approach lends itself to a much more effective application of a formal control system than the previous approach. The objective of communication is achieved

through the dialogue process employed to define each subordinate's goals. The objective of motivation is achieved since each subordinate manager is aware that he will be evaluated by the goals which he jointly established with the AIMD Officer. The objective of diagnosis is achieved since the AIMD Officer is provided information as to accomplishment of subordinate goals which should sum to accomplishment of the organization's goals. The organization's goals, of course, are derived from the overall organization's goals. (i.e., the Navy's goals) and can be used to evaluate the effectiveness of current programs in accomplishment of these higher goals.

c. Observations of Actual System

The focus of the reporting system under the Case I management approach was on the general use of trend lines to indicate an improving or deteriorating situation. Under the approach taken in Case II, some trend lines are used but the primary emphasis is placed on analysis of specific parameters. For instance, the product of each work center is analyzed in depth in terms of the percentage of total items inducted which were made RFI; and, for these items which were not made RFI, specifically, why not and what is being done to correct the situation. If, for example, an item was beyond capability of maintenance (BCM) because of a lack of equipment, tools, facilities, or technical data, then the corrective action which was taken to obtain the missing capability factor must be described. An analysis of manpower utilization is also accomplished by work center for

various categories of effort such as support actions, incorporation of TDC's and completion of repair. Other key areas of detailed analysis are TAT's by work center and readiness status and utilization of GSE.

d. Evaluation of Approach

The significance of the reporting system described above lies not so much in the aspect of detailed analysis, but rather in the fact that the subordinate managers (both Division Officers and Work Center Supervisors) are responsible for defending the results at monthly meetings. The data are presented in graphic form which provides for easy interpretation and the floor is open to participation from all attendees. The real advantage of this approach is that it brings the subordinate managers into active participation in the overall effort. The AIMD Officer is thereby freed from concentrating on the daily problems which arise and can direct his attention to longer-range problems and programs. Perhaps one disadvantage of this approach lies in the fact that these meetings for detailed analysis of operations by work centers occur only once per month. Under this circumstance, a problem situation may develop and become out of control before it is discovered through this group analysis process.

3. The Computerized Approach (Case III)

This approach is unique in that it is the only case analyzed in which the management control system was attempted to be placed on a real-time computerized basis. It is perhaps an exaggeration or distortion to refer to this sytem

as a management control system since it was in practice more of an operational control system in that it focused on the rather narrow task of tracking components through the AIMD repair cycle. It was designed, however, with the end in mind of providing additional information which would be useful from a management control standpoint.

a. Management Approach

This approach to management assumes that any given operation or set of operations can be reduced to specific steps that can be adequately described and programmed into a computer. The major drawback of this approach, as described in Ref. 5, is that it ignores the human element involved in any on-going organization. The diverse activity involved in any AIMD organization is so complex that it would be extremely difficult, if not impossible to reduce the total activity to a definable set of programmable steps. The myriad of minor, but necessary, decisions which are routinely handled by various AIMD personnel would require an enormous computer capacity to achieve the same degree of efficiency in operations.

b. Implications of Approach

Tho first problem encountered in the introduction of a computerized product is that of human resistance. What a person doesn't understand or can't actually see in operation becomes mysterious and suspect, not to be trusted or relied upon. Given this attitude, it is extremely difficult to assign goals to subordinates and evaluate their performance

by means of measurement generated by something new, different, and somehow suspect. It would seem then that the utility of reports would be highly dependent on the success of a training program to educate and familiarize personnel with the system. The success of this type of system also requires the active support of top-level management (i.e., the AIMD Officer) if it is to be accepted and implemented. In other words, the computerized system, may generate a wealth of information covering every facet of the organization's operation, but if the top level manager does not have personnel, workers and subordinate managers, who will accept this information and the responsibility for corrective action based on this information, then the entire process is an exercise in paperwork. Conversely, unless the top level manager believes in the system, accepts the information being generated, and is willing to take action based on this information, then the system loses much of its value for management control.

c. Documented Results of Trial System

While the operation of the AIMD organization under this approach was not observed, the results of the system are well documented in Ref. 14. The objectives and results are briefly described below.

(1) Decreased Processing Time of Components. This is the amount of elapsed time from the removal of the component from the aircraft until the time it is actually inducted into a work center for maintenance. One significant factor of this total elapsed time is the amount of time that transpires between the time that a squadron is issued an

RFI component and the time that the failed component is received by the screening section in AIMD from that squadron. During this time interval, the failed component is referred to as an "outstanding IOU." After the introduction of the Case III system, the average number of outstanding IOU's at any given time decreased from 68 to 29.

(2) Decreased Amount of Time That a Component Is In an AWP Category. After the introduction of this system, the average number of components in this category decreased from 467 to 441. This was significant at the .01 level [Ref. 14].

(3) Decreased Turnaround Times (TAT). After the introduction of this system, 73 percent of the components evaluated had reductions in TAT. This was significant at the .05 level [Ref. 14].

(4) Decrease in Required Inventory Levels. As a result of the above improvements (i.e., improved turn-in times, etc.), it appeared that an overall reduction of eight percent in rotatable pool assets could be achieved.

(5) Reduction of A-799 Components. Another objective of this system was to increase productivity through timely identification of items inducted which had no defect (coded as A-799). Results obtained during the evaluation period for the system indicated that an annual savings of 5,100 manhours (approximately a 25% reduction) could be obtained at the test AIMD installation by early identification of these components.

(6) Early Identification of High-Failure Items. Some components experience a significantly higher failure rate than normal. If components were monitored by serial number tracking, then early identification of these components could be realized and they could be removed from the system (to depot overhaul) before an excessive number of repeat inductions occurred. As a consequence, a savings in manhours could be realized. Results obtained during the trial period indicated that approximately 32,100 manhours could be saved annually at the test AIMD installation.

(7) Other Objectives. Additional savings could be achieved by the reduction of clerical personnel resulting from computerized operations and the use of computer-generated reports in place of manually-prepared reports. Results obtained during the trial period indicated that a reduction of two billets and further savings of 400 manhours annually could be achieved.

d. Evaluation of Approach

It seems prudent to question whether the results obtained above are significant (i.e., in the cases of the reduction in AWP category and TAT's) or even if they were the result of the introduction of the computerized system. Perhaps the results were obtained more from the effect of increased management attention than from the computerized system. However, even if the improvements resulted solely from the computerized system, this system does not appear to be a totally satisfactory implementation of a management

control system since it does not achieve all of the necessary objectives of management control. In addition, the trial system is much too narrow in scope from a management control standpoint and does not capture enough of the various elements to be managed by the AIMD Officer. Certainly, it does appear to be a useful tool or subsystem of an overall management control system.

IV. RESULTS OF ANALYSIS AND SUMMARY

A. INTEGRATION OF THEORETICAL AND EMPIRICAL ASPECTS

As many different points have been discussed thus far, it would seem appropriate at this point for a brief review of what has been covered.

1. Review of Major Points

Briefly, these points are as follows:

a. An AIMD is a department of a Naval Air Station which performs designated maintenance functions.

b. The AIMD Officer is the head of the department and he utilizes some form of management control system to communicate, to motivate subordinates through evaluation, and to provide diagnostic data.

c. The management control system that the AIMD Officer utilizes is typically an individualized system that reflects his experience, his perceptions and his personality. However, whatever the particular nature of the system installed, it is constrained to the extent that the AIMD organizational structure, objectives, and certain management functions (budgeting, reporting, etc.) are prescribed by NAMP and various other policy instruction from higher authority.

d. The stated objectives of the NAMP which appear to be applicable to the AIMD organization are:

(1) Improved performance and training of maintenance personnel;

(2) Improved aircraft availability;

(3) Improved maintenance integrity and effectiveness;

(4) Improved safety;

(5) Improved utilization of maintenance manpower and materials;

(6) Improved planning and scheduling of maintenance work;

(7) Improved quality of end product.

e. Management control is the process by which managers insure that resources are obtained, used, and disposed of, effectively and efficiently, to accomplish the organization's objectives within imposed constraints.

f. In order to achieve effective control of the organization's operations, certain specific performance yardsticks must be developed to be used as the basis for communications with and evaluation of subordinates and the compilation of diagnostic data. The development of these performance yardsticks must take into account the realities of constraints imposed by the organizational characteristics and the strategy of the overall organization (i.e., the Navy).

g. Certain principles should be adhered to in the development of these performance yardsticks.

(1) The measurements should measure the performance of the organizational components (i.e., divisions and work centers) rather than the performance of the manager.

(2) The measurement indices should be common between divisions and work centers, but the standards of performance should be tailored.

(3) The measurements should be designed as an aid to judgement and not as a substitute for it.

(4) The measurements should somehow provide proper weight to future performance as well as current performance.

h. Specific key result areas must be defined which are critical to continued successful operation of the AIMD organization and performance yardsticks (i.e., indices) must be developed for these areas. One possible set of key result areas for an AIMD has been defined along with an indication of the purpose of the indices for each areas as follows:

(1) Service. The purposes of the indices in this case are to: recognize the contribution of capital investment and manpower to the level of service provided, recognize "organizational facts of life," and influence managers and subordinates to make operating decisions in the best interests of the overall organization (i.e., the U. S. Navy).

(2) Market Service Position. The purpose of the index in this area is to recognize the share of the market serviced by the AIMD during the operating period.

(3) Productivity. The purpose of the indices in this area is to: measure the relationship of output of goods and services to resources consumed, recognize capital

and labor inputs, segregate from the measurement the effects of improvements or degradations contributed by outside sources.

(4) Service/Product Leadership. The purpose of the index in this area is to appraise the initiative of the AIMD in applying the most advanced knowledge in development of new products or improvements in quality or value of service.

(5) Personnel Development. The purpose of the index in this area is to measure the degree and effectiveness of systematic training, both formal and on-the-job, of managers and technicians.

(6) Personnel Attitudes. The purpose of the index in this area is to determine the degree of job satisfaction/dissatisfaction.

(7) Inter-command Responsibility. The purpose of the index in this area is to determine the degree of responsiveness to certain specific commands (e.g., Functional Wing Commanders, Squadrons, etc.) who have a vested interest in AIMD performance.

(8) Balance Between Short-Range and Long-Range Goals. The purpose of the index in this area is to emphasize the importance of long-term visibility in changes in base-loading, modification programs, phase-out of existing programas, introduction of new programs, etc.

i. The AIMD must contend with and manage a set of elements which may be viewed from two standpoints, as constraints or as resources. They are constraints in the sense

that the particular nature, quality, or quantity of each element was determined by higher authority with little or no input from the AIMD Officer. They are resources in the sense that they are what the AIMD Officer has to work with in conducting the daily operations of his organization. These elements are:

(1) Maintenance Concept. The concept is an expression of the particular maintenance philosophy developed for a type of aircraft and associated systems during the design stages. Specifically, what maintenance functions (i.e., checkout, servicing, fault isolation, replacement, etc.) are required and at what level (squadron, AIMD, or depot) will they be performed.

(2) Support and Test Equipment. The maintenance concept will specify that certain maintenance functions will be accomplished at the AIMD level. The accomplishment of these functions will require the use of certain items of common GSE and certain items of peculiar GSE.

(3) Supply Support. This element impacts the AIMD in two ways. First, the AIMD functions as a supply source in the sense that it provides RFI components to the supply system. Secondly, the AIMD functions as a supply user in the sense that it obtains required spare parts from the supply system to effect repair or failed components.

(4) Transportation and Handling. This element encompasses the functional requirements and actions necessary to ensure the capability to transport, preserve, package

and handle all equipment and support items. Although this element is primarily the responsibility of the Supply Department, the AIMD Officer has a vested interest in assuring that it is given adequate attention.

(5) Technical Data. This element includes drawings, operating and maintenance manuals, parts-breakdown-structure manuals, parts lists, etc..

(6) Facilities. This element is comprised of types of facilities, locations, space requirements, and environmental factors (lights, power, air-conditioning, etc.).

(7) Personnel and Training. This element encompasses the establishment of specific manning requirements, prerequisite training, and on-the-job and formal training programs.

(8) Support Resource Funds. This element consists of those activities necessary to determine and compute funding requirements, monitor expenditures, update current requirements, and forecast future requirements.

(9) Management Information. This element consists of that recordable information which is collected and presented as either formal or informal reports.

j. The AIMD organization, when viewed as a whole, has the characteristics of a discretionary expense center in that the total output of the organization cannot be reduced to quantifiable terms and that the magnitude of the AIMD's task is primarily determined by higher authority through budgetary and manpower constraints.

k. The production divisions within the AIMD appear to have the characteristics of cost centers in that each produces a definite, quantifiable output and consumes a definite, quantifiable amount of resources.

l. The management control process, as it applies to the AIMD environment, consists of the following elements:

(1) Programming. The development of a time-phased plan of actions that are intended to execute the overall strategy and achieve the overall goals of the organization.

(2) Budgeting. The development of an operating plan in terms of funds and manpower by work center for the next operating period.

(3) Reporting (Internal). The summarizing and reporting of actual results against each division or work center.

(4) Analysis of Performance. The comparison of actual results with previously established goals and analysis of any resulting variances.

m. The Maintenance Data Collection System (MDCS) consists of several subsystems: The Manhour Accounting (MHA) subsystem, the Maintenance Data Reporting (MDR) system, and the Aviation Ground Support Equipment Statistical Data system, and constitutes a vast reservoir of available data.

2. Integration of Key Points

An attempt will now be made to integrate the significant points which were discussed above. This integration

may be somewhat easier to comprehend if the points are rearranged in an order that reflects the logical sequences of application.

a. Application of Key Points

First, if the AIMD Officer is to properly direct the operations of his organization by assuring that resources are obtained, used, and disposed of, effectively and efficiently, then he must ensure that the programming, budgeting, reporting, and performance analysis steps of the management control process are accomplished. Further, he must ensure that these steps are accomplished within the constraints imposed by higher authority and that the accomplishment of these steps serves to move the organization towards the realization of formally stated objectives and goals of the NAMP. In developing his programs and budgets he must consider the various maintenance elements such as maintenance concept, supply support, common and peculiar GSE, etc.. Finally, in order to accomplish the performance analysis step and lay the basis for achieving the objectives of communication, motivation through evaluation, and diagnostic capability, he must define the key result areas for his organization and develop performance indices for each area consistent with certain principles. He should also strive to utilize available resources (e.g., existing data bases) to the maximum extent feasible.

b. Matrix of Application of Key Points

The inter-relationships of these various elements are graphically depicted as in Figure IV-1a and IV-1b.

AIMD Management Control Process

	Programming (By Program)				Budgeting (By Work Ctr)				Perf Analysis (By Work Ctr)				Reporting (By Work Ctr)				
Logistic Elements	A-6	A-7	S-3	Etc	640	642	740	Etc	640	642	740	Etc	640	642	740	Etc	Key Result Areas
Maintenance Concept																	Service
Support & Test Equipment																	Market Service Position
Supply Support																	Productivity
Transportation and Handling																	Service/Product Leadership
Technical Data																	Personnel Development
Facilities																	Personnel Attitudes
Personnel & Training																	Inter-Command Responsibility
Support Resource Funds																	Short-Range and Long-Range Goals
Management Information																	

Figure IV-1a

Relationship Between Performance Indices, Key Result Areas, and NAMP Objectives		
Performance Indices	Result Areas	NAMP Objectives (Improvements in:)
Availability, Utilization, Items Repaired Items BCM'd, T_S, EMT, Y-Codes	Service	Maintenance integrity and effectiveness, performance of personnel, quality of product, planning and scheduling, utilization, availability
Repair actions per flight hour	Market Service Position	--
A-799, Non-routine actions, Availability, Utilization, Hours utilized per item processed	Productivity	Maintenance integrity and effectiveness, performance of personnel, planning and scheduling, utilization, quality of product
Submissions to Cost Reduction, Beneficial Suggestion, UR & RAMEC	Service/ Product Leadership	--
Effectiveness of training, Level of proficiency attained	Personnel Development	Training of personnel
Identification of problem areas, Plans of corrective actions, Progress against plan	Personnel Attitudes	--
Actions undertaken, Manhours consumed, GSE time expended	Inter-Command Responsibility	--
Detection of program change, Evaluation of impact, Recommended action	Short-Range & Long Range Goals	--

Figure IV-1b

These depictions indicate that the key result areas, as defined, reflect the objectives established by the NAMP (with the exception of the objective of improved safety). As previously emphasized, it must be kept in mind that this is just one definition of the set of key result areas for AIMD and many more possible definitions exist. Similarly, the objectives established by the NAMP could be achieved by means other than those indicated; however, it is felt that this definition of the key result areas would be effective in achieving the NAMP objectives. Also, note that the scope of performance reflected in the key result areas is much broader than that reflected in the NAMP objectives. Although improved safety has not been developed as a key result area, it should be reported since it is stated as an objective in the NAMP. Note that the time frame under consideration decreases with each step of the management process in going from left to right in Figure IV-1a. That is, the programming step requires the longest time frame to be considered (as far into the future as possible), the budgeting step is for the next reporting or annual period, the reporting and performance analysis steps would be primarily performed against the reporting period just completed. However, the performance analysis step also serves as a bridge to the future in the sense that it evaluates the progress of the overall results of AIMD with regard to the continuing effectiveness of current programs towards accommodation of long range program changes. Also, note that the programming step is defined in terms of

aircraft-type programs; whereas the remaining steps are in terms of work centers (or divisions, where applicable).

As stated previously, the key features of existing management control systems which appeared to be particularly useful would be incorporated in the proposed system. In this regard, it is felt that the management by objectives approach is particularly useful since it actively involves the management at the levels which are closest to the daily operating problems and, therefore, best able to take timely corrective action. This level is primarily that of the Work Center Supervisor; hence, operating results and performance analysis should be primarily accomplished against Work Centers. To this end, the proposed management control system is based on this approach.

B. DEVELOPMENT OF PERFORMANCE MEASUREMENT INDICES

The following paragraphs will develop performance measurement indices for each key result area. The following guidelines will be adhered to:

1. Utilization of MDCS

Existing data elements or reports (within the MDCS) will be utilized to the maximum extent possible.

2. Principles of Development of Indices

The principles to be adhered to in developing measurement indices are outlined in paragraph IV A-1-g. The indices developed in each of the key result areas comply with these principles in that they measure the performance of the work center rather than the work center supervisors,

they are common between work centers, they serve as an aid to judgement, and provide weight to future performance in the sense that they indicate whether or not long term corrective action should be undertaken (i.e., should design changes or other remedial action be undertaken to improve MTTR,? Should more spares be procured if MTTR cannot be improved?).

3. Method of Applying Indices

It has been mentioned several times in the discussion that the AIMD Officer should do this, monitor that, have an interest in, etc.. It is realized that the AIMD Officer simply does not have the time to do all of these things; yet, they must be accomplished, and he has a responsibility to see that they are. This is, of course, accomplished in actual practice by delegation of authority and, as advocated here, through the management by objectives approach.

In each functional area (avionics, GSE, etc.), the AIMD Officer has two levels of key subordinates: The Division Officer, and the individual Work Center supervisor within the division. The Work Center supervisor should monitor and be intimately familiar with the measurement indices for all components repaired in his work center; however, if it is impractical to present all of this information to the Division Officer, then the report(s) should be tailored for significant items of interest. Similarly, the Division Officer should tailor the information presented to the AIMD Officer.

What then is a reasonable basis for tailoring the information to be presented if it cannot be presented in its entirety? One approach is to borrow a concept from inventory control called the "ABC plan." This concept is presented in detail in Reference 16, but basically it involves dividing the total inventory (or products in this case) into categories based on usage and value. Those items which have the highest combinations of usage and value receive the greatest amount of attention and control, whereas those with the lowest combination of value and usage receive the least amount of attention and control. If the factor of value is measured in terms of priority of AIMD workload [Ref. 2], and the factor usage is replaced with a factor of manpower expended, then this concept can be applied to determining which components should be reported "up the line."

There are four categories of AIMD workload priorities and if each category is arbitrarily assigned a weighting factor (for instance the highest priority a weight of 4, next highest 3, etc.), the various types of components repaired by a given work center placed in one of the categories, and the number of manhours expended to repair one unit of each type of component, then a table similar to Table IV-1 may be prepared for each work center. The information presented in Table IV-1 may be depicted graphically as in Figure IV-2.

ABC Plan for Priority and

Manpower Usage by Component

Component	Units Repaired	Priority	Equiv Weight	% Weight	MHRS Expended	% MHRS
1	50	4	200	40	100	10
2	50	3	150	30	300	30
3	50	2	100	20	400	40
4	50	1	50	10	200	20
.	.	.	.	.	.	.
.	.	.	.	.	.	.
Totals	200	-	500	100%	1000	100%

Table IV-1

Percentage Equivalent Weights vs. Percentage Manhours

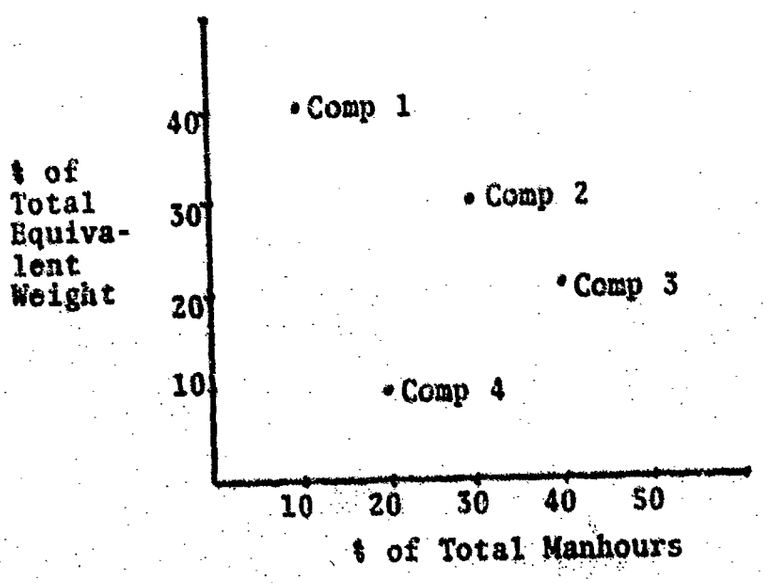


Figure IV-2

In this case, the Division Officer and AIMD Officer should receive reports on components 1, 2, and 3 if time constraints limited reporting to only three of the four types of components repaired. It should be noted that the use of this approach implicitly puts emphasis on two traditional areas of keen interest: items which contribute to NORS situations (Priority 4) and high-manhour consumer items. Since it will be mandatory in most cases, due to time constraints, for some form of screening to take place before components are selected for presentation to the Division Officer and AIMD Officer, the approach of the "ABC" concept appears to be a satisfactory tool for accomplishing this screening. It is envisioned that the Work Center Supervisor would develop information as depicted in Table IV-1 and Figure IV-2 for all components repaired in his work center and screening would be accomplished on the basis of this information. This screening would be accomplished on a monthly basis and specific components would be added or dropped as conditions warranted.

C. SERVICE

Before proceeding further, discussion of exactly what is meant by "service" is in order. Service will be defined as the product of normal operations of the AIMD which consists primarily of the repair of failed components and central management of certain items of standard ground support equipment (commonly referred to as "yellow gear"). This excludes extraordinary actions taken on the basis of requests

from external commands which are addressed below under the key result area of inter-command responsibility. This service is provided to basically two clients: the Supply Department and squadrons being supported. In either case, the client's perception of how good the service is will be measured in terms of how quickly the AIMD responds to his demand for service and whether or not a satisfactory product was obtained.

1. Purposes of Indices

As stated previously, the indices should serve the following purposes: recognize the contribution of capital investment and manpower to the level of service provided, recognize the "organization facts of life," and influence managers to make decisions in the best interests of the Navy.

2. Contribution of Capital Investment and Manpower to Level of Service Provided

The first point to be considered is exactly what services are provided. As defined above, this consists primarily of repair of failed components and central management of standard items of ground support equipment (GSE). The second point to consider is that of the disposition of items which were inducted into AIMD for repair. Were they repaired or not? The third point to be considered is that if an item was repaired, how long was the TAT and is this TAT acceptable? Is the quality of repair acceptable? If it was not repaired, why not, and what was the disposition? The final point to be considered is that of the standard GSE. What was the availability and utilization of the GSE

which is under the centralized management of AIMD? Each of these points will now be considered.

a. Availability and Utilization of Standard GSE

(1) Definition of Indices and Sources. The appropriate measurement indices for this factor are self-evident. The availability and utilization of each item of standard GSE should be reported on a monthly basis. These indices are presently available from the MDCS (GSE-1 and GSE-3).

(2) Application and Presentation. The Work Center Supervisor would be responsible for tracking all items of GSE under his cognizance. A sample format for the accomplishment of this responsibility is presented in Figure IV-3. Screening of these items would be accomplished by the Supervisor and higher management levels of application of the "ABC" principle and presented to the AIMD Officer on a monthly basis. A sample format is presented in Figure IV-4.

b. Number of Items Inducted and Disposition

(1) Definition of Indices and Sources. The appropriate indices for this factor are the actual number processed, the number repaired and average TAT, and the number which could not be repaired (i.e., declared BCM) and average TAT (i.e., days after induction until declared BCM). This information may be obtained from the present MDCS (MDR-8-1 through MDR-8-4 and MDR 10).

GSE Availability/Utilization

Work Center 930 Month of Sep

Item of GSE	# Units Reported	Total Hrs Reported	% OPRUV	Hours Available	Hours utilized	% Utilizwd	% NORS	% NORM Sched	% NORM Unsked	% AWM	% AWP

Fig IV-3

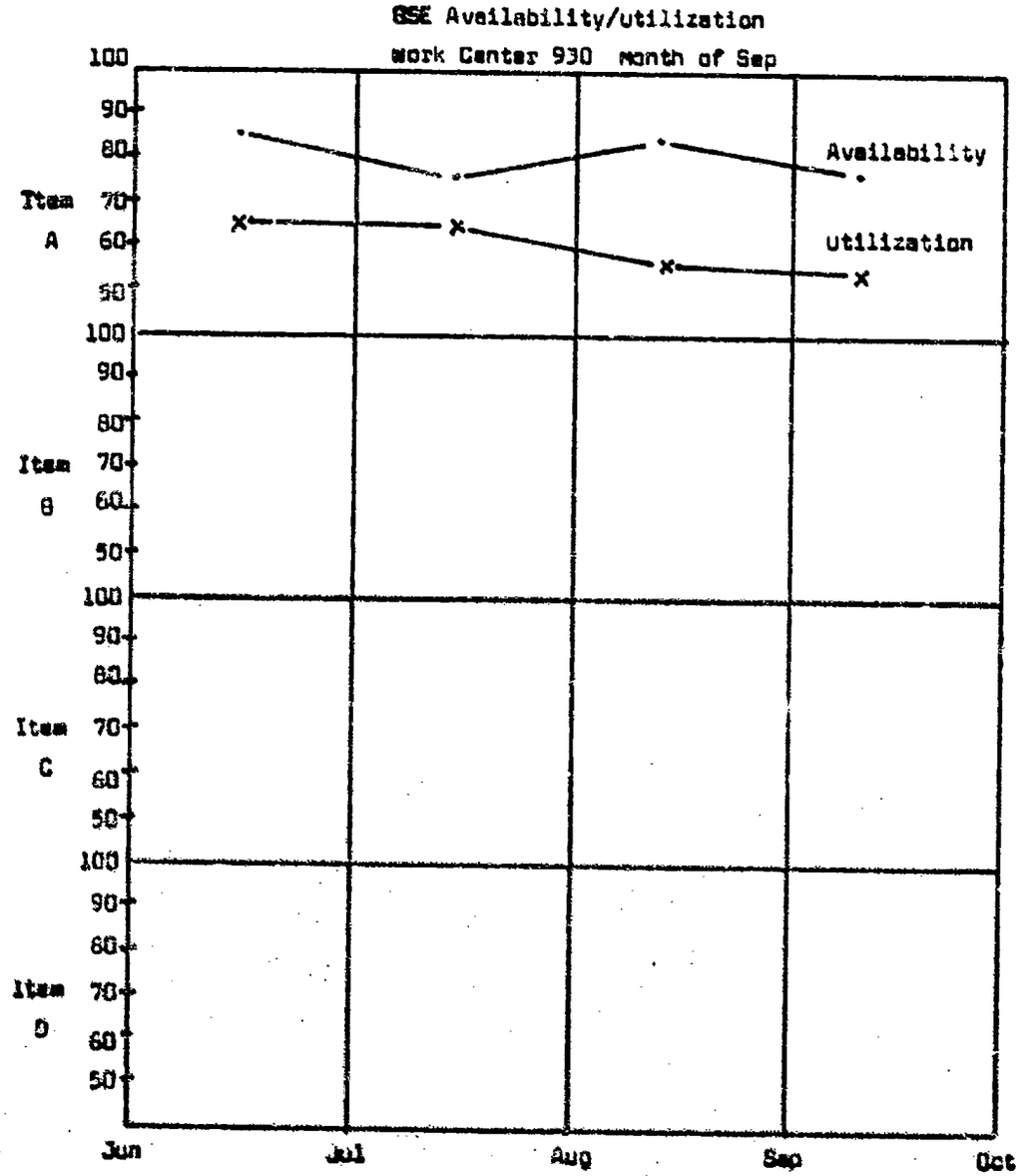

GSE Availability/utilization
Work Center 930 Month of Sep
Availability
utilization
Item A
Item B
Item C
Item D
100
90
80
70
60
50
Jun
Jul
Aug
Sep
Oct

Fig IV-4

(2) Application and Presentation. The Work Center Supervisor would be responsible for tracking all components under his cognizance. A sample format for accomplishing this task is presented in Figure IV-5. Screening of these components would be accomplished as before and presented to the AIMD Officer on a monthly basis. A sample format is presented in Figure IV-6.

c. Elements of TAD

As previously expressed, it is unfair to hold the AIMD Officer accountable for or measure the performance of his organization against overall TAT figures. An appropriate performance index for the timeliness of AIMD response should be related to TAT's, but not a one-for-one relationship. The TAT for a component is the total elapsed time from removal of the failed component from the aircraft until it is returned to the supply system in RFI condition or classified as beyond capability of maintenance (BCM) and forwarded to a higher-level repair facility.

The total amount of elapsed time referred to as TAT is composed of several factors: the elapsed time in days from removal to receipt at the AIMD screening unit (referred to as processing time and designated as T_p), the elapsed time in days from receipt at screening until induction into a work center for repair (referred to as scheduling time and designated as T_S), the elapsed time in days from the induction into the work center until completion of repair or BCM action (referred to as repair time and

Components Inducted/Repaired/BCM'd

Work Center 642 Month of Sep

Component	Total Number of Items Processed	Number Items Repaired						Total Rep. Total Proc.	Avg TAT	Number of Items BCM'd									Total BCM'd Total Proc.	Avg TAT	Explanation of BCM Action
		A	B	C	J	X	Other			1	2	3	4	5	6	7	8	9			

Fig IV-5

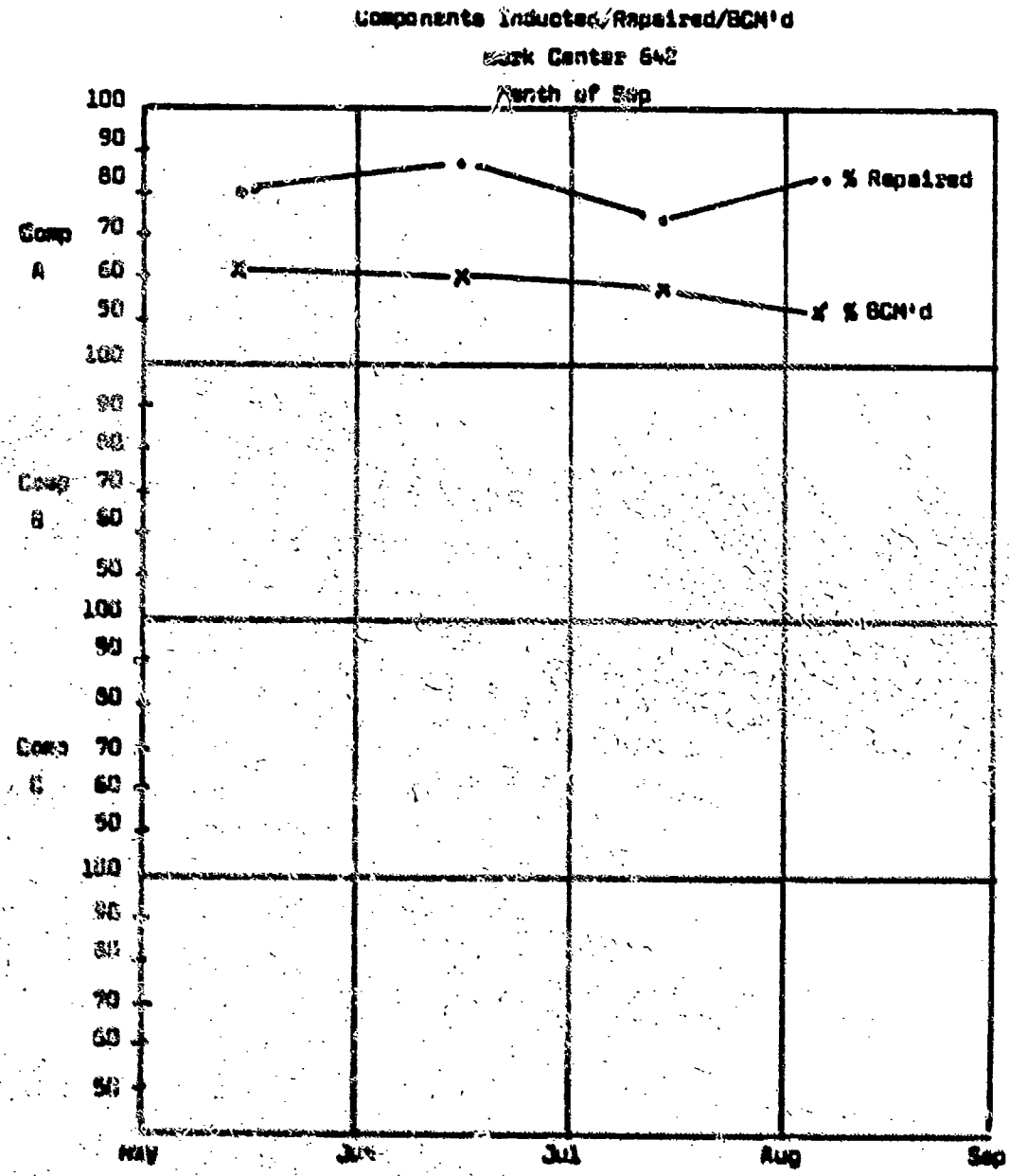

Components Inducted/Repaired/BCM'd
Work Center 642
Month of Sep
% Repaired
% BCM'd
Comp A
Comp B
Comp C
100
90
80
70
60
50
May
Jun
Jul
Aug
Sep

Fig. IV-6

designated as T_R), and the elapsed time in days that the component is in the category of awaiting parts (referred to as "AWP" and designated as T_A). The total turnaround time, TAT, may then be represented as:

$$TAT = T_P + T_S + T_R + T_A$$

The AIMD Officer has primary control over only the elements of T_S and T_R and these are the elements he should measure his divisions and work centers against. However, the AIMD Officer also has a vested interest in the other two elements, T_P and T_A, and these should also be monitored where problem areas can be brought to the attention of the Supply Department.

(1) Definition of Scheduling Time (T_S). The primary factors that determine the T_S factor are queuing considerations, backlogs in the Work Center, or preemption by higher priority work. The capital equipment (i.e., test benches) impact this factor in one respect which is the amount of time required to reconfigure the test bench by changing the electrical harness, initial set up of power switches, etc.. The Work Center, in order to attain an efficiency in operation, must wait until a queue of components of one type has developed which will make it worthwhile to reconfigure the test bench for that particular type of component. Otherwise, the work center would spend more time setting up and breaking down the bench configuration than spent on doing the actual repair. A minimum

standard of performance for each component, by work center, may be derived by application of formal queuing theory to the following situation. As described in Reference 9, inventory levels for rotatable pool items are established on the basis of three criteria: TAT, demand rate, and fill-rate goals. Or restating, TAT is a function of inventory levels, demand rate, and fill rate goals. In other words, a given combination of inventory levels, demand rates and fill-rate goals for a component held in the rotatable pool sets a maximum limit on the amount of TAT which can be tolerated for that component. Now, the average values of T_P, T_R, and T_A which are actually being experienced may be obtained from the MDCS (MDR-10). Hence the maximum allowable T_S value under the required TAT may be found as follows:

$$T_S(max) = TAT(req) - T_P - T_R - T_A$$

From queuing theory [Ref. 15], the following relationship applies to a single-service facility (i.e., only one test bench) with arrivals from an infinite population. (This theory applies to the situation under discussion as long as there are replacement components available to squadrons from the rotatable pool):

$$E(W) = \frac{E(Nq)}{A}$$

where E(W) = average waiting time in the queue

E(Nq) = number of items waiting in the queue

A = average number of items arriving in one unit of time (measured in units of days for consistency with MDCS)

Now letting $E(W) = T_S$ max and rearranging:

$$E(Nq) = \frac{T_S(max)}{A}$$

The Quantity, A, may also be determined from the MDSC (MDR-9) which enumerates the number of failures during a period for a given component. The number of failures during the period divided by the number of days in the period yields the quantity A.

Thus, the maximum number of items in the queue, E(Nq)max, which can be tolerated under the required TAT may be determined for each component. This minimum standard provides a simple visual check for maintenance control and the Work Center Supervisor by determining the number of components of a given type in the backlog, comparing it to the standard, E(nq)max, and determining whether a problem situation is developing or not. Likewise, the AIMD Officer will be able to compare the average T_S for a component with the $T_S(max)$ standard for that component for the reporting period and determine whether the respective work center is trending towards a problem situation.

The AIMD Officer can also develop a longer range perspective by determining if the pool quantity allowances and fill-rate goals established by the supply system impose an unrealistic $T_S(max)$ under the prevailing demand

rates and value for T_P, T_R, and T_A. In other words, if the $T_S(max)$ which must be observed approaches the amount of time required just to configure the test bench for the repair of that component type, then the situation is unrealistic. This is, of course, an extreme case and would probably never actually occur; however, the nature, if not the degree, of the problem is very real. It should be noted that this approach assumes the existence of standard values for T_P, T_R, and T_A and constant demand rates, fill-rate goals, and pool quantity allowances. If the values for T_P, T_R, or T_A can be improved, then the $T_S max$ can be relaxed if the remaining factors remain constant. The one factor which is quite likely to fluctuate is the demand rate. The impact of this factor will be discussed in the key result area of market service position.

(2) Definition of Repair Time (T_R). Repair time is the other factor of TAT which is controllable by the AIMD Officer. Both capital investment and manpower impact this factor. During the design and development phase of the system acquisition, a Maintenance Engineering Analysis)MEA) should have been accomplished for all major components of the system. This analysis determines the primary failure modes that will be encountered and the maintenance skills, man-hours, parts, test equipment, etc., that will be required to effect repair of these failure modes. These various factors are embodied in a design specification imposed on the ground support equipment (test bench) called the Mean Time to Repair (MTTR). The average elapsed maintenance time

(EMT) for the repair of each type of component should be compared to this design specification and if the EMT is significantly higher than the MTTR, the problem should be investigated. Similarly, the results of the MEA should indicate the manhours required to effect a given maintenance function. If the average manhours actually being expended is significantly higher than the figure developed by the MEA, then the problem should be investigated.

Both the average value for EMT and for manhours expended in the repair of each type of component can be obtained from MDR-1. The control of the T_R element should be of keen interest to the AIMD Officer since it is a prime ingredient of how well AIMD is perceived to be performing its service. Thus, the AIMD Officer should move quickly to analyze any problems which are detected and initiate corrective action. This is easier said than done because the basic problem may lie in any one of the following areas: lack of skills due to inadequate training, inadequate maintenance procedures, test equipment design deficiencies or any combination of them. It is vital that these problems be brought to the attention of higher authority also, since total spare buys, established manning levels, etc., are based on the results of the MEA and design specifications such as MTTR.

(3) Application and Presentation. The Work Center Supervisor should be responsible for monitoring the performance indices for all components repaired in his work center. A sample format for this purpose is presented in

Figure IV-7a. The first column indicates the component by Work Unit Code (WUC), the second column gives management an indication whether the component is included because it is a high priority item or a high manhour usage item or both. The third column provides a comparison of the TAT being utilized by the supply system to determine rotatable pool allowance quantities with the TAT being actually achieved. The fourth column provides the average processing time actually being experienced which should remain fairly constant. The fifth column provides a comparison of the scheduling time (T_S) actually being experienced to the $T_S max$ that can be tolerated for the given constants of pool quantity allowances, TAT, demand-fill goals and actual average values of T_P, T_R, and T_A. The sixth column provides the average value experienced for repair time. The seventh column provides the average amount of time that a component actually spends in the AWP category. The eighth column provides a comparison of the average EMT with the design parameter of MTTR. The ninth column provides a comparison of the average number of manhours actually expended with the number of manhours predicted by the MEA. The last column relates the component to aircraft type and subsystem. These components would be screened as before and certain components selected for presentation to the AIMD Officer on a monthly basis. A sample format is presented in Figure IV-7b to report to the Division Officer and AIMD Officer.

Comparison of Actual Performance to Effectiveness Standards

Work Center 642 Month of Sep

Component	Priority	TAT (Con) / TAT (Act)	T_P	T_S Max / T_S Act	T_R	T_A	MTTR / EMT	MHR (MEA) / MHR (Act)	Acft Types S/S

Fig IV-7a

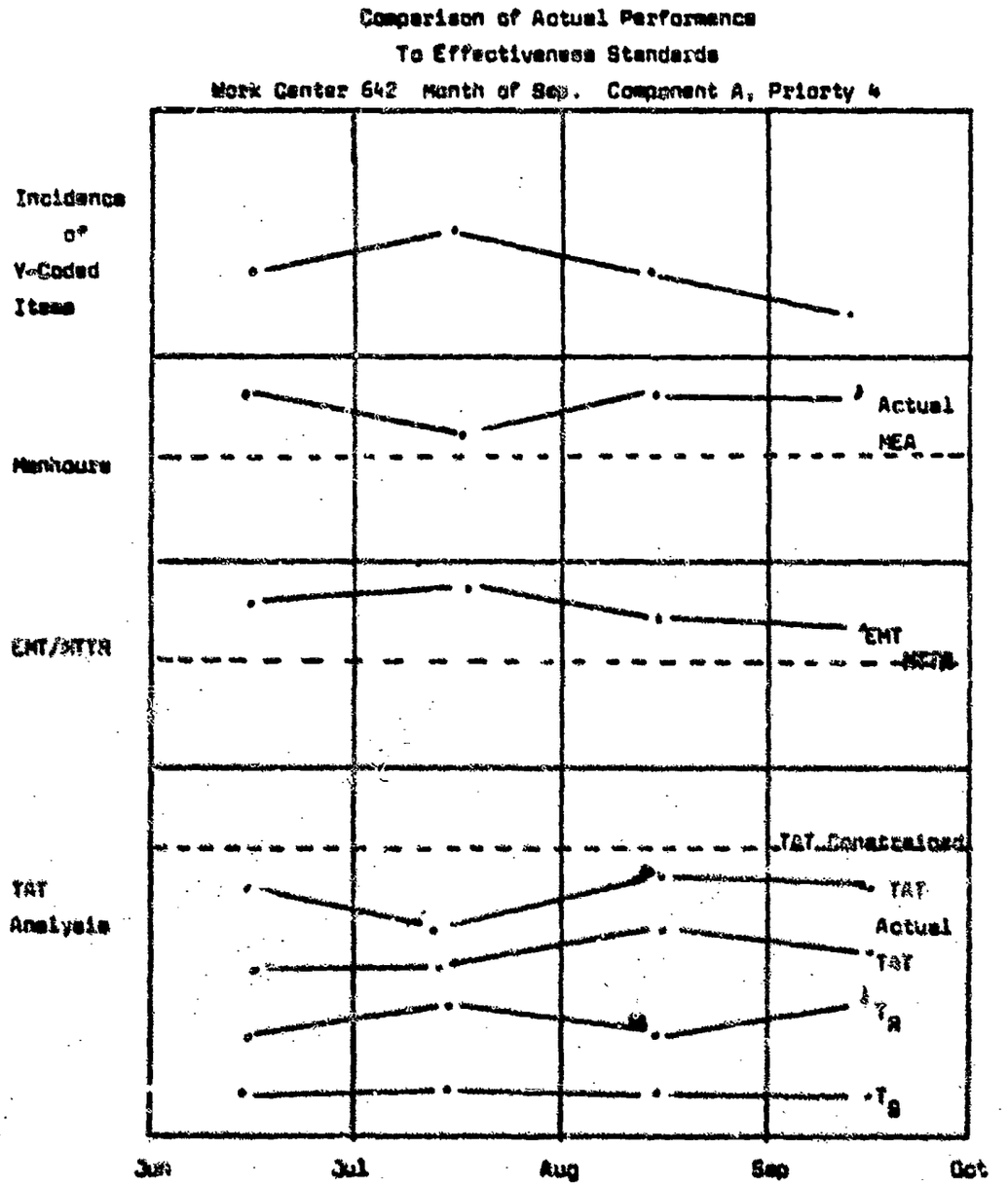

Comparison of Actual Performance
To Effectiveness Standards
Work Center 642 Month of Sep. Component A, Priority 4
Incidence of V-Coded Items
Manhours
Actual
MEA
EMT/MTTR
EMT
TAT Analysis
TAT Comparisons
TAT
Actual TAT
Jun
Jul
Aug
Sep
Oct

Fig IV-7b

d. Quality of Repair

(1) Definition of Source of Index. The other factor which reflects on the quality of service provided by the AIMD is the number of items which are discovered to be defective when they are received from the AIMD (via the supply system). These items are given a "when discovered" code of "Y." Hence, the term Y-coded items. The incidence of occurrence of Y-coded items for each type of component may be obtained directly from the MDCS (MDR-S-8).

(2) Applications and Presentation. The Work Center Supervisor should be responsible for monitoring the incidence of Y-coded items for each component. This could be accomplished by adding another column to the format presented in Figure IV-7a. The AIMD Officer could establish a maximum permissible level of incidence and any component exceeding this maximum level would receive exception reporting.

3. Recognition of Organizational Facts of Life

The organizational facts of life are recognized by dividing the total TAT into its composite elements and accepting the fact that the processing time (T_P) and the time that components are in the AWP category (T_A) are beyond the control of the AIMD Officer. He can bring problems in these areas to the attention of the Supply Department, but his primary emphasis must be on the elements of scheduling time (T_S) and repair time (T_R). The indices of T_S and T_R reflect the contribution of capital investment and manpower to the level of service provided. A

comparison of the average values of EMT and manhours expended which are actually experienced with the design specification of MTTR and the projected manhours derived from the MEA should encouraged the AIMD Officer to report significant variances to higher authority since he is the one who will suffer the consequences of silence. Certainly it is in the best interests of the Navy to highlight the facts that equipment is not meeting specifications, required manning levels have been understated, or not enough spares have been procured.

D. MARKET SERVICE POSITION

1. Purpose of Index

The purpose of this index is to recognize the market serviced by the AIMD during the reporting period. The AIMD Officer does not actively seek a larger and larger share of the market; however, an increasing or decreasing share of the market is realized with the coming and going of squadrons located at the parent NAS. As a result, the demands placed on the AIMD fluctuate directly with number of aircraft located on-board the NAS and with the tempo of operations (i.e., number of flight hours per period). As the number of aircraft being supported increased or the number of flight hours per month increases, the demand rate for services increases, the number of failed components in the backlog queue increases, and the level of service (as measured by TAT) will decrease unless corrective action is taken.

2. Definition and Source of Index

By relating the total flight hours for each component for the period (obtained from ASD-3 or ASD-5 by identifying the component with the respective aircraft system) with the number of component repair actions for that period (obtained from MDR-S-10), then a ratio of repair actions to aircraft flights hours may be obtained. This ratio is not presently available in direct form from the MDCS but could be easily developed by programming changes. Trend lines may then be developed and used to detect potential trouble areas. This data may also be utilized as a planning tool to project required test bench time and manpower for future periods if a flight hour forecast can be obtained from the squadrons or Functional Wing Commander.

3. Application and Presentation

The Work Center Supervisor should be responsible for tracking these ratios for each component for which he has cognizance. This information could be incorporated into the format depicted in Figure IV-5. Screening of these components would be accomplished as before and presented to the AIMD Officer in the same format as indicated in Figure IV-6 except that the ratio of repair actions to flight time would be depicted instead of percentage of items repaired or BCM'd.

E. PRODUCTIVITY

This key result area has traditionally received a great deal of management attention and rightly so. Two key words, effectiveness and efficiency, apply to any operation and

the AIMD is no exception. Efficiency has been described as doing something right and effectiveness as doing the right something [Ref. 3]. Effectiveness (doing the right something), in the case of the AIMD, is reflected in the key result area of service. Efficiency is reflected in the key result area of productivity. The emphasis that these two areas receive is indicated by the way the NAMP objectives are clustered in these two areas (refer to Figure IV-1b).

1. Purposes of Indices

Productivity may be defined as follows:

$$\text{Productivity} = \frac{\text{number of components processed}}{\text{manhours consumed}}$$

Where, specifically, the number of components processed relates solely to the number of items repaired and returned to an RFI status. The key factors to look for in this situation are those which tend to increase the number of items processed and those which tend to inflate the number of manhours consumed. There are three primary purposes of the indices developed for this area: to measure the relationship of output goods and services to resources consumed, to recognize capital investment and labor inputs, and to segregate the effected caused by external sources.

2. Segregation of Effects of External Sources

a. Definition and Source of Index

This index should provide a measure of how much particular effects caused by outside sources create inefficiences in the production process. This primarily occurs

as a result of components being turned in for repair which have no defect. The MDCS (MDR 8-2) presently provides a listing of actions taken by type component for each work center. The specific action code for items turned in for repair that have no defect is "A-799." This category of items is also referred to as "no-defect" items. The MDR-8-2 lists only the overall category of action-taken code "A" which may contain not only removals for no-defect items, but also for other reasons such as removal for trouble-shooting, etc.. The majority of A-code listings, however, wi'l be for no-defect (A-799) and the entire listing may be practically regarded as such. Inefficiencies may also result from actions taken in behalf of the key result area of inter-command responsibility. Examples of such actions are: breaking the production run to process a high priority item, attending conferences, etc., at the request of external commands. A certain amount of this type of ineffiency must be accepted in the interests of responsiveness; however, manhours expended towards this end should be segregated and accounted for (refer to paragraph IV B-7). At present, the MDCS does not provide the data required for this index. The vehicle exists, however. in the Monthly Labor utilization report (MHA-2). A labor category code would have to be defined, perhaps in the 870 category; but, this could easily be accomplished. The basic idea is to document and report the manhours expended at the behest of external commands towards all non-routine actions that degrade the efficiency

of normal operations. It is felt that the impact of actions in this area is more significant than generally realized.

b. Application and Presentation

As previously discussed in the case of the effectiveness indices, the Work Center Supervisor should have a detailed knowledge of each of these indices. If a total listing of all such actions by component type would be too voluminous or too time-consuming for presentation to higher levels of management, then selectivity could be achieved through application of the "ABC" concept as previously demonstrated or as determined by higher management (i.e., Division Officer or AIMD Officer). Figure IV-8 indicates a possible format for use by the Work Center Supervisor and Figure IV-9 indicates a possible format for use in reporting to higher management. The columns in Figure IV-8 are self-explanatory and are intended to segregate and highlight the impact of actions or requests of external organizations on the efficiency of normal operations. The information presented in Figure IV-9 is merely a graphical representation of the information contained in Figure IV-8 and historical information which has been added to develop perspective.

3. Recognition of Capital Investment and Manpower Inputs

a. Definition and Source of Indices

The simplest means of determining the contribution of these factors is to determine what was available for what period of time and how well it was utilized. The percentage availability of each item of major ground support equipment (either common or peculiar) may be obtained from

Work Center 642 Month of Sep

Components	A-795 Actions	A-799 Manhours	Number Items	Non-routine Actions Due External Commands			Comments
				Specific Action	Manhours Expended	Organization	

Fig IV-8

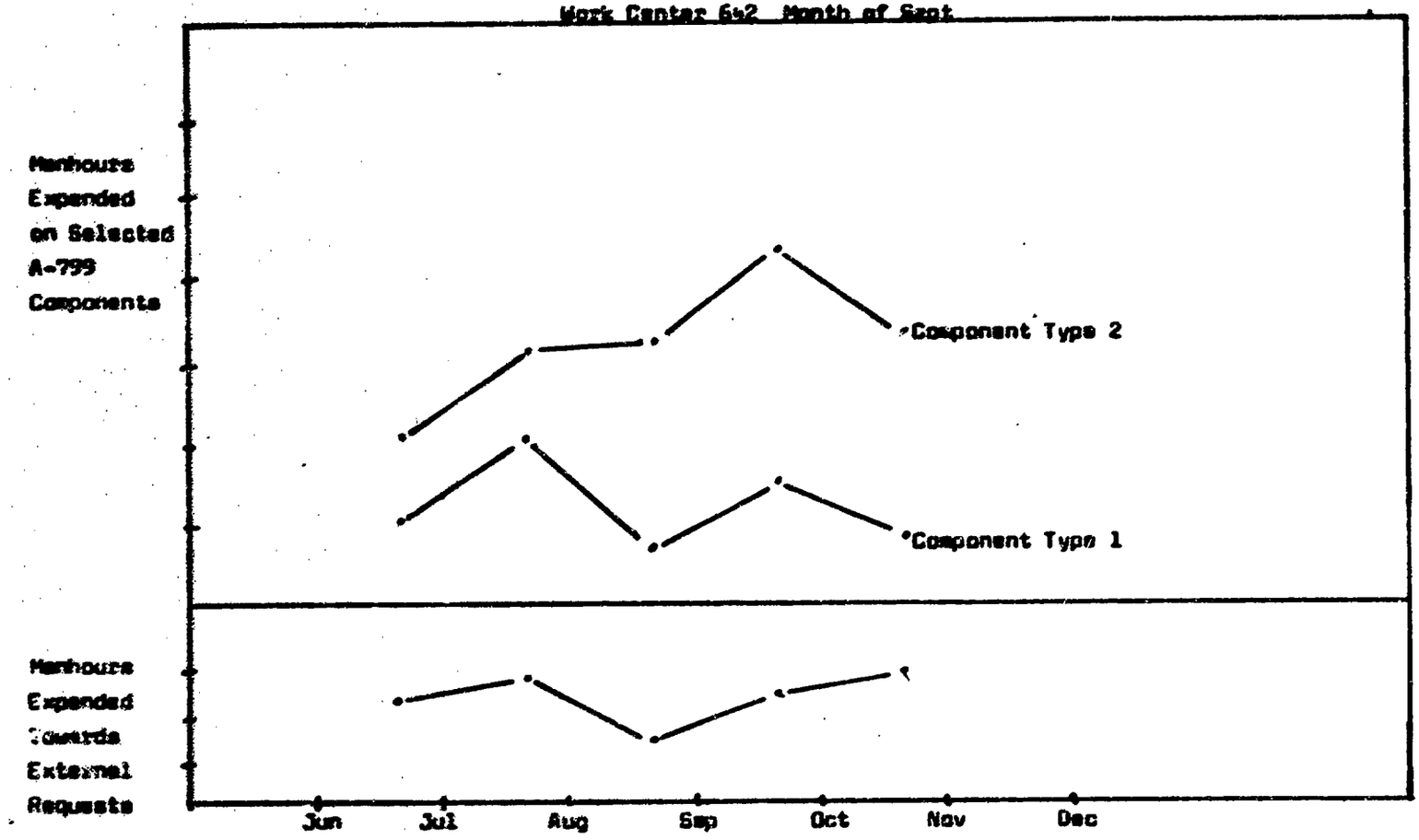

Work Center 642 Month of Sept
Manhours Expended on Selected A-799 Components
Component Type 2
Component Type 1
Manhours Expended Towards External Requests
Jun
Jul
Aug
Sep
Oct
Nov
Dec

Fig IV-9

the monthly GSE-3 report. This is a primary performance measurement index from an overall standpoint since it constrains the index of EMT for test benches used to maintain the repairable items.

The NAMP calls for a total production time of 176 hours per month (22 days x 8 hours/day) for manpower utilization. If a similar standard is applied to capital equipment (test benches), then for a one-shift operation with 100 percent availability (operationally ready), 176 hours of machine time would be available. If the GSE-3 report indicates a significantly lower utilization, then either, at times, there is no backlog against the test bench and the equipment is sitting idle, or there is a shortage of qualified manpower to keep the equipment fully employed, or an excessive amount of time is being spent on breakdown and reassembly of the test bench configuration. Similarly, the number of manhours assigned by work center and how this manpower was utilized may be obtained from the MHA-2 report. At present, it is not possible to further segregate this data by item of GSE with the MDCS. It would not be that difficult to accomplish, however, by assigning subcodes to specific items of GSE within each work center and reprogramming to collect this information by test bench device.

b. Application and Presentation

The Work Center Supervisor should be responsible for tracking the productivity of his work center in terms of these indices. A suggested format for performing this task

is presented in Figure IV-10. A suggested format for presentation to the AIMD Officer is presented in Figure IV-11.

4. Relationship Of Outputs to Resources Consumed

a. Definition and Source of Indices

In the final analysis, this is the essence of productivity. How much was produced at what cost? Again, it is felt that the appropriate level to make this type of measurement is at the level of each major item of GSE. This is the lowest level at which manpower, materials, and equipment are combined to produce a useful output and the level where problems can best be detected and corrective action taken. Appropriate indices are the number of hours of GSE time utilized per item processed and the number of manhours consumed per item processed. These indices are not presently available from the MDCS but could be obtained by applying the subcoding process described above in paragraph IV E-2-a and making the necessary programming changes.

b. Application and Presentation

The Work Center Supervisor should be responsible for tracking the productivity of his work center in terms of these indices. A suggested format for performing this task is presented in Figure IV-12. A suggested format for presentation to the AIMD Officer is presented in Figure IV-13.

F. SERVICE/PRODUCT LEADERSHIP

1. Purpose of Indices

The purpose of the indices in this area is to assess the initiative of the organization in applying the most

Work Center 642 Month of Sep

Item of GSE	Number of Units	Percentage Availability	Hours Available	Per Cent Utilized	Hours Utilized	Manhours Assigned	Manhours Utilized	Manpower % Utilized

Fig IV-10

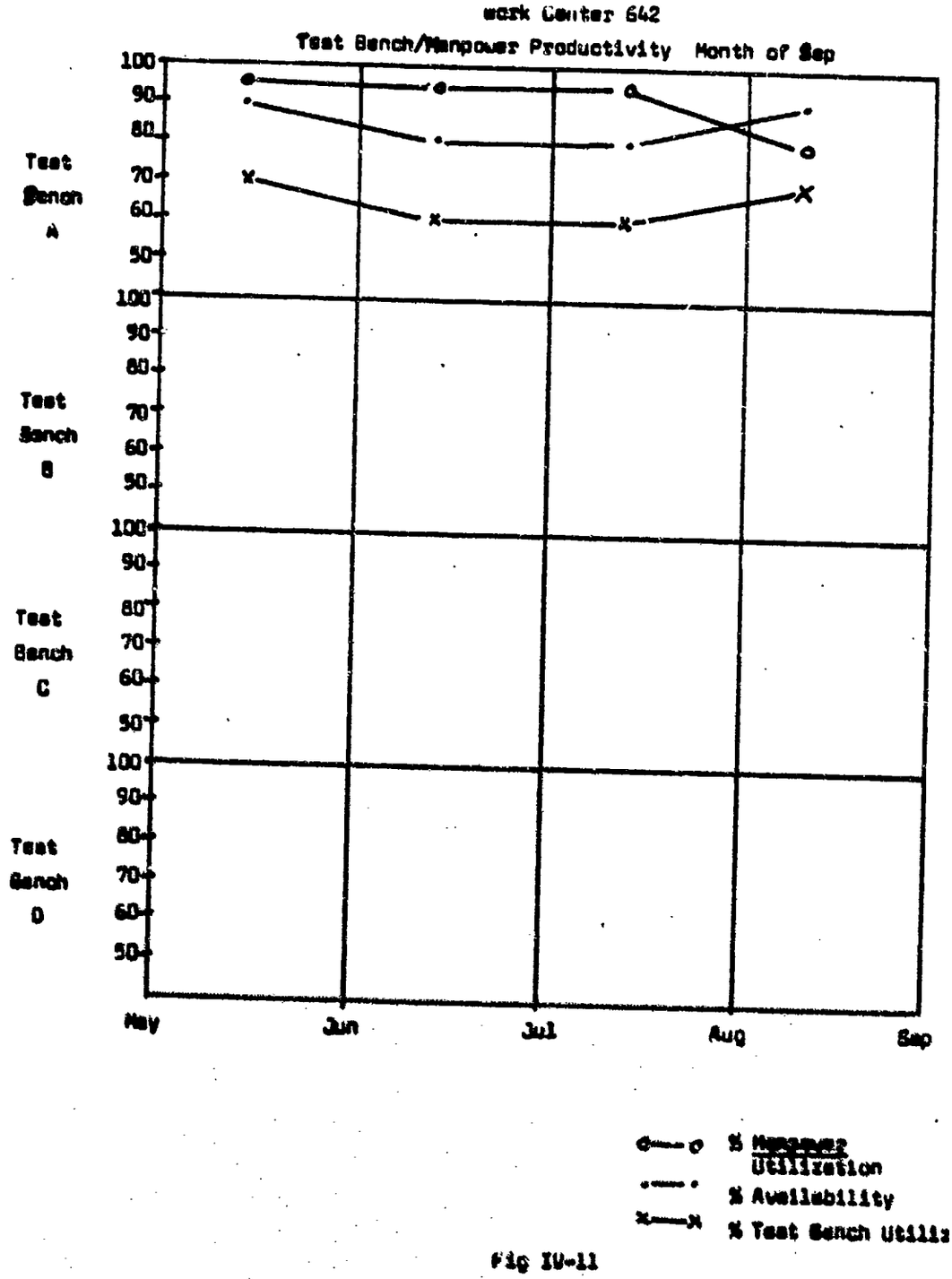

Work Center 642
Test Bench/Manpower Productivity Month of Sep
Test Bench A
Test Bench B
Test Bench C
Test Bench D
100
90
80
70
60
50
May
Jun
Jul
Aug
Sep
% Manpower Utilization
% Availability
% Test Bench Utiliz

Fig IV-11

Work Center 642

Overall Productivity Month of sep

Item of GSE	GSE Hours Utilized	Manhours Utilized	Components Processed	GSE Hrs Utilized/Comp Processed	Manhours Utilized/Comp Processed	

Fig IV-12

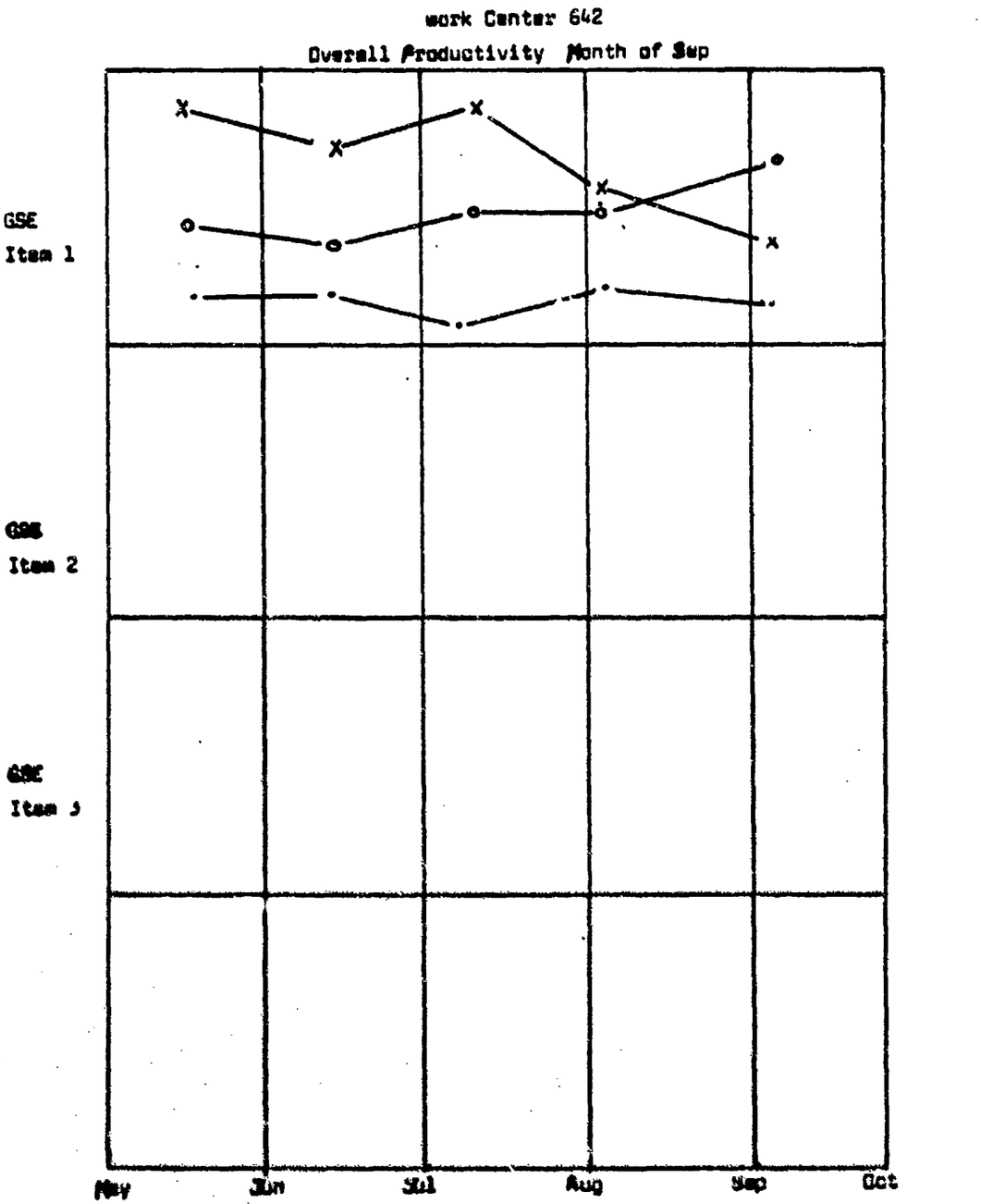

Work Center 642
Overall Productivity Month of Sep
GSE
Item 1
GSE
Item 2
GSE
Item 3
May
Jun
Jul
Aug
Sep
Oct
Note - Scale determined by magnitude of indices
X—X No Components Processed
Mhrs utilized/comp proc
GSE hrs utilized/comp processed

Fig IV-13

advanced knowledge or ingenuity in development of new products or improvements in cost, quality, or value of service.

2. Definition and Source of Indices

Several programs presently exist which serve as the basis for measurement of performance in this area: the Cost Reduction Program, the Rapid Action Maintenance Engineering Change (RAMEC) program, the Unsatisfactory Reporting (UR) System, and the Beneficial Suggestion Program. A monitoring system would have to be established, perhaps at the branch or division level to collect this data.

3. Application and Presentation

Tracking and status of submissions in each of these areas should be accomplished by the Division Officer. Figure IV-14 is a sample format for use by the Division Officer. The same format should be usable for presentation to the AIMD Officer. All columns are self-explanatory.

G. PERSONNEL DEVELOPMENT

The requirement for a formal training plan is established by the NAMP. The effectiveness of implementation of this plan should be guided by the performance measurement indices developed for this area.

1. Purpose of Indices

The purpose of the indices in this area is to measure the degree and effectiveness of systematic training, both formal and on-the-job (OJT) of managers and technicians. The primary focus of the measurement indices will again be on the respective Division Officers rather than the work centers. This placement of emphasis should achieve a higher

600 Division

Service/Product Leadership Month of Sep

Program	Status	Comments
Cost Reduction Past Submissions Current Submissions		
Beneficial Suggestion Past Submissions Current Submission		
Unsatisfactory Reports Past Submissions Current Submissions		
RAMEC'S Past Submissions Current Submissions		

Figure IV-14

degree of efficacy since the Division Officer is in a better position to screen the training records of incoming personnel and determine the training requirements of each individual based on the position in which he will be placed.

2. Definition and Source of Indices

Once the Division Officer has determined the training requirements that must be accomplished for each individual, both to meet continuing requirements established by organizational policy and to achieve a "fully trained" status for the individual, then the number of manhours to be accomplished in each category, by work center and division, should be forecast for the next reporting period. At the end of each reporting period, the number of manhours actually documented for training should be compared to the number forecast for the period. Both the forecasts and compilation of actuals should be expressed in terms of the labor codes established by the NAMP.

Technical Training (formal)	- LC080
Technical OJT	- LC100
Military Training	- LC090

The training received may derive from a variety of sources: Naval Air Technical Training Command Schools (Class A, B, C, P, or O); Naval Air Maintenance Training Groups (NAMTG); Naval Air Rework Facilities (NARF's); or in-service training (both formal and OJT). The AIMD Officer is not so much interested in what the source of training is, but rather in how effective it was in terms of the number of manhours lost

to productive service compared to the increase in proficiency achieved. The development of this index or indices requires that once the training requirements are established for an individual, then an estimate must be made of the number of manhours required to complete this training. At the end of the period, the number of training manhours remaining to be completed can be deducted from the like number at the beginning of the period and the result summed for each work center. This work center total can then be compared to the total hours lost to the work center as a result of training for that period and the effectiveness of training derived.

A separate index can also be developed for each work center and division which will reflect the overall qualifications and proficiency level of that division or work center for each period. In this case, a basic minimum of training must be established for each position (i.e., basic "A" schools, "B" schools, etc.). Then a training syllabus and estimated manhours for accomplishing that syllabus would be established to qualify an individual as "fully trained" for each position. Each individual being placed in a particular position would then be screened against the basic and follow-on requirements to become fully-qualified. For example, if the follow-on training requirements required 350 manhours of training and a particular candidate for the job had already attended a two-week required course, then he would be 23 percent qualified. That is,

$$\frac{\text{2 weeks} \times \text{5 days/week} \times \text{8 hours/day}}{\text{350 hours}} = \frac{80}{350} = 23\%$$

3. Application and Presentation

A composite format for the use of the division officer is presented in Figure IV-15. An example of a possible format for presentation to higher authority is presented in Figure IV-16. The columns in Figure IV-15 are self-explanatory. The data presented in Figure IV-16 is basically the same information as presented in Figure IV-15, (first segment is the same as column 5, second segment the same as column 6, etc.) with historical data added to provide perspective.

H. PERSONNEL ATTITUDES

1. Purpose of Indices

The purpose of the indices in this area is primarily to determine the degree of job satisfaction/dissatisfaction with regard to work content, work environment, and relations with co-workers, subordinates and superiors.

2. Definition and Source of Indices

A recent Navy-wide development has made available an ideal tool with which to develop insight and accomplish corrective action. This development is the Navy Human Resource Management (HRM) Support System as outline in Reference 17. The HRM support system provides not only a formalized approach to identifying potential trouble areas and implementation of corrective action, but also provides for professionally-trained, expert assistance in carrying out the approach.

.. The HRM Survey

The primary diagnostic tool is the HRM Survey. Although the survey will most likely be accomplished for the

600 Division

Personnel Development Month of Sep

Work Center 642 Position/Incumbent	MHR Req for Full Qualificat'n	Manhours Remaining Begin Period	Manhours Remaining End Perd	Net Trng Accomp	Trng MHR Documented During Perd	Effectiveness of Training	Level of Proficiency Attained at End of Period
ALQ-49 Tech/Jones ALR-42 Tech/Smith Total							
Work Center 650 Position/Incumbent . Total							
Division Total							

Fig IV-15

600 Division

Personnel Development Month of Sep

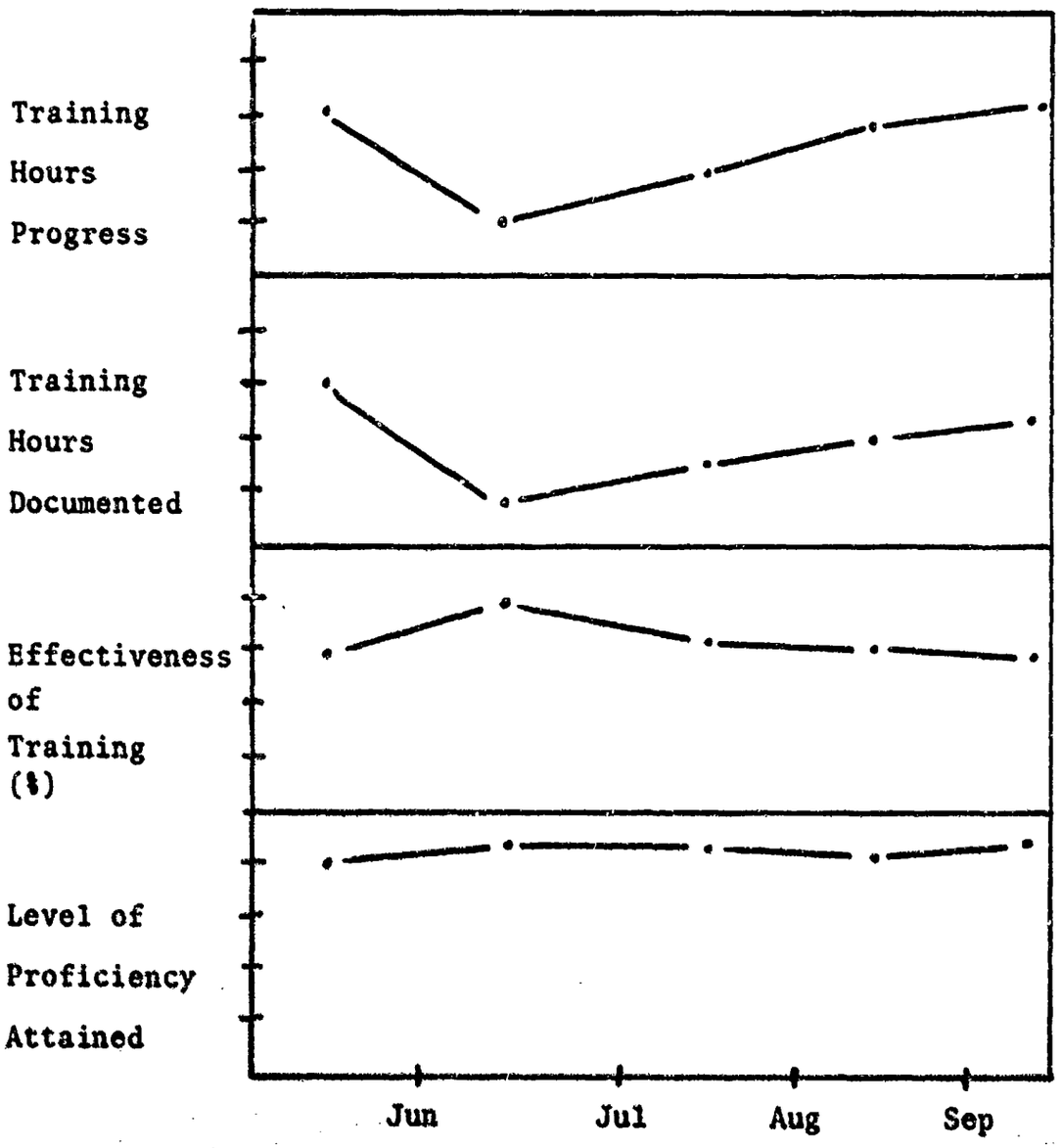


Figure IV-16

overall NAS organization of which the AMID is a part, a specific section which reflects only the AIMD will be available to the AIMD Officer. The Survey provides sampling data with regard to the following areas [Ref. 17].

(1) Command Climate. Communications flow, decision-making, motivation, human resource emphasis, lower-level influence.

(2) Supervisory Leadership. Support, teamwork, goal emphasis, work facilitation.

(3) Peer Leadership. Support, teamwork, work facilitation, problem-solving.

(4) Work Group Processes. Work group coordination, work group readiness, work group discipline.

(5) Satisfaction.

(6) Integration of Personnel and Mission.

(7) Training.

(8) HRM Areas.

b. The Command Action Plan (CAP)

The development of the CAP should be based on the result of the HRM Survey. The exact content of the CAP is of necessity highly tailored to each organization's particular problem areas as determined by the HRM Survey. Consequently, it is difficult to suggest specific indices or a format for general application. This entire result area is by nature quite subjective, which constrains the proposed plans and actions and evaluation of results to be similarly subjective in nature.

3. Application and Presentation

One possible format which is based on the suggested elements for the CAP [Ref. 17] is presented in Figure IV-17. The information contained in the first two columns should be derived from and traceable to the results of the HRM Survey. The remainder of the information should be developed on the basis of group participation. Problem areas should first be discussed by the Division Officer, Work Center Supervisor, and Work Center personnel and specific correction action and goals proposed. The Division Officer should then discuss these proposals with the AIMD Officer and, if accepted by him, formalize the actions and goals to be reported against on a monthly basis.

I. INTER-COMMAND RESPONSIBILITY

1. Purpose of Indices

The purpose of the indices in this area is to determine the degree of responsiveness to certain commands such as the squadrons being serviced, the Functional Wing Commander, etc., which have a vested interest in AIMD performance.

2. Definition and Source of Indices

This key result area is closely aligned with the key result area of service in that both contribute to the degree of responsiveness to demands put on the AIMD. The distinction lies in what can be considered as normal operations and measured in the area of service and what can be considered as extraordinary actions and measured in the area of responsiveness. The resources consumed in the first area should be expended on an optimal basis (e.g., in view of the TAT

600 Division

Human Resource Management Month of Sep

Statement of Problem (Key to HRM Survey)	Organization Unit Trouble Areas	Corrective Action Goal	Division Officer Action	Start Date / Projected Comp Date	Current Status	Wrk. Ctr Supervr's Action	Start Date / Projected Comp Date	Current Status
1. Lack of lower-level influence	Work Center 642 654							
2. Inadequate work group co-ordination	work Center 670 690							

Fig IV-17

to be observed, how many items should be permitted to queue in the backlog to obtain the most efficient production run), whereas the resources consumed in the second area are expended without regard to optimality or even effectiveness. They are expended solely on the basis of courtesy (or direct orders) to external commands. These actions should be monitored with respect to the specific action, the organization requesting this action, the number of manhours expended, and the amount of GSE time consumed. This information has basically been developed in paragraph IV E-1-a for each work center for the purposes of documenting inefficient manhours expended because of external sources. The emphasis here is on the total number of inefficient manhours and test bench time consumed by which organization and for what purpose.

3. Application and Presentation

A sample format is presented in Figure IV-18. This information would be compiled by the Work Center Supervisors, consolidated by the Division Officer and presented to the AIMD Officer. The AIMD Officer would utilize this information in executive-level discussions with his counterparts. Most information is presently available in the MDCS although special coding would have to be applied as previously described to identify specific actions as extraordinary. Other information such as attendance at conferences and meetings coul also be obtained through the MDCS by special coding.

600 Division

Intercommand Responsibility Month of Sep

Organization	Actions undertaken	Manhours Consumed	GSE Time Expended	Comments
WP-47	Work Request XXX	43	10.7	Fabricate floor panel
NAS Supply	ER 466 thru 495	1563	432	High priority items NIS
Functional Wing	1. Provide representatives to ECP review Maintainability Conf	76 83		ATC Jones, AT1 Brown
	2. Special evaluation of component R3	84	222	Evaluation successfully completed

Fig IV-18

J. BALANCE BETWEEN SHORT-RANGE AND LONG-RANGE GOALS

1. Purpose of Indices

The purpose of the indices in this area is to emphasize the importance of long-range visibility in changes in base-loading, modification programs, phase-out of existing programs, introduction of new programs, etc.. In other words, the intent of this key result area is to keep the AIMD Officer (and his subordinates) attuned to changes happening in the "external world" and enable him to get and maintain the "big picture."

2. Definition and Source of Indices

Far-reaching changes are typically effected in terms of aircraft programs (i.e., A-6, A-7, S-3, etc.) and should be monitored and evaluated on this basis. Unfortunately, the AIMD organizational structure is not conducive to the assignment of this responsibility to functional subordinates; consequently, this area will require the designation of specific personnel as program monitors. Each program monitor would be responsible for staying abreast of current developments and projected plans for his particular program. He would also be responsible for making preliminary evaluations of impending or proposed changes and communicating these evaluations to the AIMD Officer and other affected personnel.

3. Application and Presentation

Each change would be evaluated as to its impact across the various logistic elements (maintenance concept, technical data, personnel, training, etc.) and adjusting action recommended. A suggested format is presented in

Figure IV-19. The information presented is of a subjective, interpretive nature which permits the AIMD Officer to stay abreast of key developments and potential problem areas.

K. SUMMARY

This section has attempted to integrate the various major points discussed in the first three sections into a coherent system (refer to Figure IV-1). The NAMP objectives were related to the set of key result areas developed in Section II and performance measurement indices were developed for each area in accordance with certain principles. A method of accomplishing the programming task of management was suggested which provides for evaluation of long-range developments in programs and recommendations for adjusting actions, both expressed in terms of the various logistic elements. It is again emphasized that the entire approach utilized and specific results obtained are not the only way of accomplishing management control, but rather is one possible way of establishing a formalized system. It is felt that the particular system described in this section is an improvement over existing systems and could be employed to great advantage.

A6 Program month of Sep

Program Change	Maintenance Concept	Support & Test Equip	Supply Support	Transport'n & Handling	Technical Data	Personnel & Training	Recommended Action
1. Phaseout of A6A's for squadron VA-165	-	Decreased demand on test benches SSE-1620 SSE-4972	Decreased demand on rotable pool items A, B, C	Lower demand for handling fixtures A & B	-	-	Transfer 1 AT from work center 641 (SSE 1620) to work center 645 (SSE-1740)
2. Modification programs ECP-142	-	Requires mod of test bench SSE-4321	Requires mod of components x, y, z	-	Revised tech documentations due 4 Sep 78	Factory training course slated for Jul 78	-
ECP-156	-	-	-	Requires mod of handling device xyz	-	-	-
3. Activation of VA- 198, 199	Increased emphasis on micro-miniature electronic repair	Increased demand on test benches SSE-1740 SSE-1930	Increased demand on rotable pool items D, E, F	Increased demand for N_2 certs	-	-	-

Fig IV-19

V. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

Several conclusions may be drawn from the various interviews conducted [Ref. 11, 12, and 13] regarding the types of management control systems presently being employed. Similarly, several conclusions may be drawn from the presentation on the proposed system regarding its utility and the possible utility of alternative systems.

1. Present Systems

The following conclusions seem significant and pertinent:

a. Design of System

The systems presently in use reflect the experience, perceptions, and personality of the particular incumbent to the AIMD Officer billet. This conclusion has no inherently negative connotation. Management, by nature, is a highly personalized undertaking and the effectiveness of this approach is undeniably successful based on the fact that AIMD organizations typically "get the job done." The disadvantage of this approach lies in the fact that it is very individualized and whenever the incumbent AIMD Officer changes, the various subordinate management tiers must also change to accommodate the new management control system. In other words, a new basis for communication and evaluation, in terms of performance management indices, must be found. Subordinate management echelons are asking themselves the

questions: "What is he (the new AIMD Officer) telling me when he says I've got to improve performance?," "How is he going to evaluate what I'm doing?" The new AIMD Officer is meanwhile asking himself the following types of questions: "How am I going to evaluate whether or not my subordinates are doing a good job?," "How can I communicate to them what I want them to do?" In other words, the systems presently in use lack standardization which creates a transitional learning problem each time an incumbent AIMD Officer is transferred. This lack of standardization also makes the performance of a particular AIMD organization (at least as far as its perceived performance is concerned) highly sensitive to the particular individual who is incumbent to the AIMD Officer position at any given time. Since not all AIMD Officers are created equal, and obviously, some are better than others, the present systems limit the performance of each AIMD to that of the incumbent AIMD Officer. Also, there is little or no transfusion of managerial talent.

b. Significance of Measurement Indices

The indices used under the present management system tend to be relative measures; comparing today's performance with that of yesterday. Again this is necessary in order to detect trends of improvement or degradation; however, it is insufficient in the sense that it does not provide a measure of how much better performance could be or how much more it could deteriorate before irreversible problems develop. Also, existing measures are not necessarily

directly relatable to NAMP objectives or key result areas. Of what benefit is it to know that a particular test bench was 100 percent available (operationally ready), unless it is also known to what extent this availability was utilized and how effective this utilization was? The present system provides a means of diagnosis from a relative standpoint, but it does not provide directly for a means of communication and evaluation at the level of the Work Center Supervisors.

c. Delegation of Authority

The precept of pushing management functions (i.e., planning, organizing, staffing, control, etc.) to the lowest levels of effective action is well recognized. Existing systems do not provide for this delegation in a positively controlled manner. Existing systems seem to be based on the concept of giving the subordinate managers full-rein to run their respective divisions or work centers as they see fit and then imposing an almost arbitrary performance measurement index or indices on each work unit to evaluate results. It is felt that mutually understood performance indices would enhance improved performance since it provides a common ground for communication and evaluation as well as a reporting format and diagnostic capability.

2. Proposed System

The proposed system provides a rational, standardized basis for management control. Though the proposed system is relatively crude at this point, the overall system and individual performance measurement indices could be refined into

an effective system which would promote the communicative, evaluative, and diagnostic capabilities of the entire organization. Specific conclusions are presented in the following paragraphs.

a. Design of System

The proposed system is designed on a rational basis. A set of key result areas are proposed based on an analogous set of key result areas for a profit-type organization which were developed by a professionally-trained staff. The NAMP objectives are related to these key result areas and performance measurement indices are developed for each key result area. The final product is a standardized system which can be implemented for all AIMD organizations. An incumbent to a particular AIMD office position would have this information available whether or not he utilized it. Also, the system seems to be broad enough to accommodate the personalized indices required under the various management control systems which were observed; consequently, the proposed system could remain intact through a succession of AIMD Officers.

b. Significance of Measurement Indices

The results of the organization, as measured in terms of the proposed indices, are much broader and more meaningful than those currently employed. Existing indices seem to focus on efficiency and effectiveness which is entirely proper in view of the mission of the AIMD; however, the current measure of effectiveness is blurred by factors over

which the AIMD Officer has no control. The existing measures of efficiency do not account for the various inefficient requirements placed on AIMD by external organizations. The totality of the operation reflected in existing indices is not broad enough to represent a true measure of overall AIMD performance. The proposed system emphasizes those factors of effectiveness over which the AIMD Officer has direct control, highlights the degradations of efficiency caused by external sources, and contains measurement indices which reflect the overall performance of the organization.

c. Delegation of Authority

The proposed system is designed with the purpose in mind of pushing the majority of management functions to the lowest management level possible, the Work Center Supervisor. The AIMD Officer must recognize that the success of the Work Center Supervisor is not based primarily on his technical skills, but rather on his management abilities.

d. Integrative Nature of Proposed System

The proposed system is of an integrative nature in several respects. It attempts to relate the goals expressed in the NAMP with the key result areas and performance measurement indices developed for the AIMD. It focuses on those elements which the AIMD Officer can directly control and improve to the advantage of the overall repair/supply cycle and, in addition, highlights other elements beyond his control, but which he can bring to the attention of appropriate parties. It ties current performance of personnel and support

equipment to the design specifications and manpower requirements established during the acquisition of the weapons system, thereby providing a means of feedback to higher level program management. It integrates the AIMD organization with its external environment by measuring performance in the key result area of responsiveness and requiring that long-range visibility be developed in all programs. It integrates many of the currently separate programs and systems (i.e., the Cost Reduction Program, Beneficial Suggestion Program, HRM system, etc.) into a coherent system. Finally, it integrates the AIMD organization from an internal standpoint by forcing the management functions to the lowest level and then measuring the performance accordingly.

3. Alternative Systems

It should be recognized that there are numerous alternative systems which could be defined outside the context of this thesis approach. Even within this approach, there are other logical alternatives. For instance, of the several key result areas defined, it is possible to select only a few of them for implementation. As a minimum, the areas of effectiveness (service) and efficiency (productivity) must be measured. Measurements in additional areas, however, could be selected depending on time and manpower constraints.

B. RECOMMENDATIONS

The following recommendations are offered on the basis of the above conclusions.

1. Refinement of Proposed System

It is recommended that the key result areas defined in this thesis be subjected to further analysis and the measurement indices further refined by personnel who have served in the AIMD management environment and developed insight into the practicality of the proposed measurement indices. Although the indices have been presented as having general application to all work centers, it is freely admitted that most were developed with rotatable pool assets in mind. This bias may tend to distort the applicability of some of the indices.

2. Implementation of Proposed System

It is recommended that the proposed system be implemented on a trial basis in selected work centers or divisions of at least two different AIMD organizations and that this implementation be done in parallel with whatever systems happen to exist at these test AIMD's. If this system proves satisfactory on a trial basis, then it is recommended that it be incorporated into the NAMP for implementation.

Appendix A

Maintenance Data Collection System Reports

Report No.	Report Title	Frequency
MHA-00	Master Roster	Monthly
MHA-1	Work Center Daily Labor Listing	Daily
MHA-2	Work Center Monthly Labor Utilization	Monthly
MHA- 3	Branch/Division Monthly Labor Utilization	Monthly
MHA-4	Organization Monthly Labor Util.	Monthly
MDR-1	Daily Projection Report	Daily
MDR-2	Monthly Production Report	Monthly
MDR-3	Job Control Number Consolidation Report	Monthly
MDR-4-1	Technical Directive Compliance Report, Part 1	Monthly
MDR-4-2	Technical Directive Compliance Report, Part 2	Monthly
MDR-5	System and Component Maintenance Report	Monthly
MDR-6	When Malfunction Was Discovered Report	Monthly
MDR-7	Maintenance Actions by Individual Item Report	Monthly
MDR-8-1	Beyond Capability of Maintenance and Repair Report, Part 1	Monthly
MDR-8-2	Beyond Capability of Maintenance and Repair Report, Part 2	Monthly
MDR-8-3	Beyond Capability of Maintenance Repair Report, Part 3	Monthly

Report No.	Report Title	Frequency
MDR-8-4	Beyond Capability of Maintenance and Repair Report, Part 4	Monthly
MDR-9	Failed Parts Report	Monthly
MDR-10	Repair Cycle Data Report	Monthly
MDR-10	Revised Repair Cycle Data Report	Monthly
MDR-11	No Defect Report	Monthly
MDRS-2	No Defect Report	On Request
GSE-1	Monthly Ground Support Equipment Utilization and Master Roster Report	Monthly
GSE-2	Daily GSE Transaction Report	Daily
GSE-3	Monthly Ground Support Equipment Readiness Report	Monthly

Appendix B

Glossary of Acronyms

ACC	Aircraft Controlling Custodian
AIMD	Aircraft Intermediate Maintenance Department
ANFE	Aircraft Not Fully Equipped
AOCP	Aircraft Out of Commission for Parts
ASD	Aircraft Statistical Data
AWI	Awaiting Induction
AWP	Awaiting Parts
BCM	Beyond Capability of Maintenance
BITE	Built-in Test Equipment
CAP	Command Action Plan
GSE	Ground Support Equipment
HRM	Human Resources Management
LOR	Level of Repair
MAF	Maintenance Action Form
MDCS	Maintenance Data Collection System
MDR	Maintenance Data Report
MEA	Maintenance Engineering Analysis
MHA	Manhour Accounting
MTBF	Mean Time Between Failure
MTTR	Mean Time to Repair
NAILSC	Naval Aviation Integrated Logistics Support Center
NAMP	Naval Aviation Maintenance Program
NAMTG	Naval Aviation Maintenance Training Group

NARF	Naval Air Rework Facility
NAS	Naval Air Station
NAVAIR	Naval Air Systems Command
OJT	On the Job Training
RAMEC	Rapid Action Maintenance Engineering Change
RFI	Ready for Issue
SAF	Support Action Form
TAT	Turn Around Time
TDCF	Technical Directive Compliance Form
UR	Unsatisfactory Report
WIP	Work In Progress

LIST OF REFERENCES

1. Office of the Comptroller, Financial Management of Resources, NAVSO Publication 3013.

2. Office of the Chief of Naval Operations, Naval Aviation Maintenance Program, OPNAV INST 4790.2A, 1970.

3. Anthony, R. N., Dearden, J., and Vancil, R. F., Management Control Systems, Irwin, 1972.

4. Anthony, R. N., and Newton, R., Planning and Control Systems: A Framework for Analysis, Irwin, 1968.

5. Huse, E. F., and Bowditch, J. L., Behavior in Organizations, Addison-Wesley, 1973.

6. Office of the Chief of Naval Material, Integrated Logistics Support Planning Policy, NAVMAT INST 4000.20A, 1971.

7. Naval Air Systems Command, Level of Repair For Aeronautical Material General Program Requirements, Aeronautical Requirement, AR-60, 1970.

8. Aviation Supply Office, Authorized Material Pool Allowance for the Component Repair and Progressive Aircraft Rework Program: Procedure for Stock Recording and Reporting of, FASO INST 4700.25, 1971.

9. Butler, P. K., and Gray, C. R., Evaluating Fill Rates for Stocks of Locally Repairable Items at Operating Activities, paper presented at Naval Postgraduate School, Monterey, CA, 1975.

10. Aero Data Inc., Airline Reliability and Maintenance Data System Notebook, 1974.

11. Kirby, R. E., CDR, USN, AIMD Officer NAS Whidbey Island, Washington, Interview of 1[illegible] December [illegible].

12. Meyers, L. J., Project Officer, Management Systems Development Office, San Diego, CA, Interview of 16 January 1976.

13. Kane, W. R., CDR, USN, AIMD Officer NAS Cecil Field, FL, Interview of 14 February 1976.

14. Management Systems Development Office, Intermediate Maintenance Activity Work in Process Inventory Control System (IMA WIPICS), MSDO Document No. M-027 TN-02, 1974.

15. Bierman, H., Jr., Bonini, C. P., and Hausman, W. H., Quantitative Analysis for Business Decisions, Irwin, 1973.

16. Matz, A. and Curry, O. J., Cost Accounting: Planning and Control, South-Western, 1972.

17. Office of the Chief of Naval Operations, Navy Human Resource Management Support System, OPNAV INST 5300.6B, 1975.

INITIAL DISTRIBUTION LIST

		No. Copies
1.	Defense Documentation Center Cameron Station Alexandria, Virginia 22314	2
2.	Commander Naval Aviation Integrated Logistics Support Center NAS Patuxent River, Maryland 20670 Attn: ILS OOB	2
3.	Library, Code 0212 Naval Postgraduate School Monterey, California 93940	2
4.	Department Chairman, Code 55 Department of Operations Research and Administrative Sciences Naval Postgraduate School Monterey, California 93940	1
5.	Commander C. P. Gibfried, USN (Code 55Gf) Department of Operations Research and Administrative Sciences Monterey, California 93940	1
6.	Commander R. E. Kirby, USN Aircraft Intermediate Maintenance Department NAS Whidbey Island Oak Harbor, Washington 98278	1
7.	Commander W. R. Kane, USN Aircraft Intermediate Maintenance Department Box 136, Naval Air Station Cecil Field, Florida 32215	1
8.	Lieutenant Commander I. L. Olden, USN Naval Air Rework Facility NAS Jacksonville, Florida 32212	1
9.	Lieutenant D. P. Mozgala, USN Aircraft Intermediate Maintenance Department NAS Brunswick, Maine 04011	1